Economic Analysis
Research Paper Series

Deaths of Canadian Manufacturing Plants: Heterogeneous Responses to Changes in Tariffs and Real Exchange Rates

by John R. Baldwin and Beiling Yan

No. 061

Statistics Canada Statistique Canada

Canada

Death of Canadian Manufacturing Plants: Heterogeneous Responses to Changes in Tariffs and Real Exchange Rates

by
John R. Baldwin and Beiling Yan

11F0027M No. 061
ISSN 1703-0404
ISBN 978-1-100-15194-6

How to obtain more information:
National inquiries line: 1-800-263-1136
E-Mail inquiries: infostats@statcan.gc.ca

April 2010

Published by authority of the Minister responsible for Statistics Canada

© Minister of Industry, 2010

All rights reserved. The content of this electronic publication may be reproduced, in whole or in part, and by any means, without further permission from Statistics Canada, subject to the following conditions: that it be done solely for the purposes of private study, research, criticism, review, or newspaper summary, and/or for non-commercial purposes; and that Statistics Canada be fully acknowledged as follows: Source (or "Adapted from," if appropriate): Statistics Canada, year of publication, name of product, catalogue number, volume and issue numbers, reference period and page(s). Otherwise, no part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form, by any means—electronic, mechanical, or photocopy—or for any purposes without prior written permission of Licensing Services, Client Services Division, Statistics Canada, Ottawa, Ontario, Canada K1A 0T6.

La version française de cette publication est disponible (n° 11F0027M au catalogue, n° 061).

Note of appreciation:

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments, and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable, and courteous manner. To this end, Statistics Canada has developed standards of service that its employees observe. To obtain a copy of these service standards, please contact Statistics Canada toll-free at 1-800-263-1136. The service standards are also published on www.statcan.gc.ca under "About us" > "Providing services to Canadians."

Economic Analysis Research Paper Series

The Economic Analysis Research Paper Series provides for the circulation of research conducted by the staff of National Accounts and Analytical Studies, visiting Fellows, and academic associates. The research paper series is meant to stimulate discussion on a range of topics including the impact of the New Economy, productivity issues, firm profitability, technology usage, the effect of financing on firm growth, depreciation functions, the use of satellite accounts, savings rates, leasing, firm dynamics, hedonic estimations, diversification patterns, investment patterns, the differences in the performance of small and large, or domestic and multinational firms, and purchasing power parity estimates. Readers of the series are encouraged to contact the authors with comments, criticisms, and suggestions.

The primary distribution medium for the papers is the Internet. These papers can be downloaded from the Internet at www.statcan.gc.ca for free.

All papers in the Economic Analysis Series go through institutional and peer review to ensure that they conform to Statistics Canada's mandate as a government statistical agency and adhere to generally accepted standards of good professional practice.

The papers in the series often include results derived from multivariate analysis or other statistical techniques. It should be recognized that the results of these analyses are subject to uncertainty in the reported estimates.

The level of uncertainty will depend on several factors: the nature of the functional form used in the multivariate analysis; the type of econometric technique employed; the appropriateness of the statistical assumptions embedded in the model or technique; the comprehensiveness of the variables included in the analysis; and the accuracy of the data that are utilized. The peer-group review process is meant to ensure that the papers in the series have followed accepted standards to minimize problems in each of these areas.

Publications Review Committee
Analytical Studies Branch, Statistics Canada
18th Floor, R.H. Coats Building
Ottawa, Ontario K1A 0T6

Symbols

The following standard symbols are used in Statistics Canada publications:

.	not available for any reference period
..	not available for a specific reference period
...	not applicable
0	true zero or a value rounded to zero
0^s	value rounded to 0 (zero) where there is a meaningful distinction between true zero and the value that was rounded
^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E}	use with caution
F	too unreliable to be published

Acknowledgements

The authors wish to thank Wulong Gu, Alla Lileeva, Ryan Macdonald, and Daniel Trefler for helpful comments. We are grateful to Bob Gibson for the creation of the database used in this paper.

Table of contents

Abstract **7**

Executive summary **9**

Introduction **11**

1 Analytical Framework **12**

1.1 Plant death and exchange rate 12

1.2 Plant death and symmetric tariff reductions 13

1.3 Plant death and other risk factors 13

2 Data source and summary statistics **15**

2.1 Data on real exchange rates 15

2.2 Data on tariff reductions 16

2.3 Data on plants 17

3 Empirical specification and results **18**

3.1 Impact of tariff cuts on exit: all plants 20

3.2 Impact of real exchange-rate changes on exit: all plants 21

3.3 Impact of industry characteristics on exit: all plants 22

3.4 Non-exporter vs. exporters 22

3.5 Domestic-controlled vs. foreign-controlled plants 24

3.6 A counterfactual experiment 25

3.6.1 All plants 25

3.6.2 Exporters vs. non-exporters 25

3.6.3 Domestic- vs. foreign- controlled plants 26

4 Conclusion **26**

References **47**

Abstract

We examine the simultaneous effects of real-exchange-rate movements and of tariff reductions on plant death in Canadian manufacturing industries between 1979 and 1996. We find that both currency appreciation and tariff cuts increase the probability of plant death, but that tariff reductions have a much greater effect. Consistent with the implications of recent international-trade models involving heterogeneous firms, we further find that the effect of exchange-rate movements and tariff cuts on exit are heterogeneous across plants—particularly pronounced among least efficient plants. Our results reveal multi-dimensional heterogeneity that current models featuring one-dimensional heterogeneity (efficiency differences among plants) cannot fully explain. There are significant and substantial differences between exporters and non-exporters, and between domestic- and foreign- controlled plants. Exporters and foreign-owned plants have much lower failure rates; however, their survival is more sensitive to changes in tariffs and real exchange rates, whether differences in their efficiency levels are controlled or not.

Key words: tariff reduction, tariff, exchange rate, plant exit, survival, failure

JEL No.: D2, F1, F3, L2, L6

Executive summary

The Canadian dollar has gone through several cycles of appreciation and depreciation relative to the U.S. dollar. It first appreciated in the early 1970s, after a period of a fixed exchange rate against the U.S. dollar. It depreciated between the mid-1970s and mid-1980s; this depreciation was followed by an appreciation in the late 1980s. The Canadian dollar then experienced a long period of depreciation over almost the entire decade of the 1990s; since 2002, the Canadian dollar has appreciated considerably, from US$0.64 in 2002 to US$0.93 in 2007.

The Canadian manufacturing sector has also had to adapt to increasing trade liberalization. The Kennedy, Tokyo, and Uruguay rounds of international-trade liberalization led to falling tariffs in the 1960s, 1970s, and 1980s. The *Free Trade Agreement between Canada and the United States of America* (FTA between Canada and the United States), which came into force in 1989, and the *North American Free Trade Agreement* (NAFTA), which came into force in 1994, followed up with even larger tariff reductions than had been experienced in previous decades.

Plants may respond to exchange-rate movements and tariff reductions in many ways. They may expand/contract existing operations, enter/exit domestic or foreign markets, relocate their production facilities, or consolidate operations through mergers/acquisitions. This paper focuses on the linkage between changes in the exchange rate and plant exit. We ask which plants are more likely to exit when the Canadian dollar appreciates or depreciates against the dollar of its largest trading partner—the United States. In examining the effect of exchange-rate movements on plant exits, we also control for other factors that may influence plant closure. These include falling tariffs as well as a set of plant characteristics, such as age, size, productivity, export status, and ownership-control status.

Plant exit plays an important role in resource reallocation and industrial renewal. While plant closure results in job losses, the "creative destruction" associated with plant turnover may also trigger innovation and improve productivity by replacing the least productive with more productive plants. Understanding the factors contributing to plant closure has important implications for industrial, trade, and foreign-direct-investment policy.

Using Canadian manufacturing plants over the period 1979-1996, we provide empirical evidence regarding the simultaneous effect of tariff reduction and exchange-rate fluctuations on plant survival. We find:

- Currency appreciation increases the probability of plant death while currency depreciation increases the probability of survival. The effect is not uniform across plants: plants that are less efficient experience an increase in their shutdown probabilities when the Canadian dollar appreciates.
- A decline in tariffs raises the probability of plant death, in particular for plants that are less efficient.

- Overall, for the period under examination, tariff reduction has a greater effect on plant exit than do exchange-rate fluctuations. On the one hand, for the period from 1984 to 1990, the rate of plant failure due to tariff reduction is about 2.6 times that of plant failure due to exchange-rate appreciation. The real depreciation of the Canadian dollar from 1979 to 1984 and from 1990 to 1996, on the other hand, decreases the exit rate. However, this decline only partially offset the increased exit probability due to tariff cuts that occurred at the same time. During the implementation of NAFTA, in the 1990s, the Canadian economy experienced a substantial depreciation in its currency that offset about 17% of the effect of falling tariffs during this period.
- There are significant and substantial differences between exporters and non-exporters, and between domestic- and foreign- controlled plants. Exporters and foreign-owned plants have much lower failure rates; however, their survival is more sensitive to changes in tariffs and real exchange rates.

Introduction

This paper is one of the few that have studied the impact of exchange rate movements on plant survival. While there are several papers that analyze the impact of tariff reductions (Head and Ries 1999; Trefler 2004; Lileeva 2008), work on how exchange rate movements affect plant survival is limited.[1] The paper provides empirical evidence on the simultaneous effect of tariff reduction and exchange rate movements on plant exit using Canadian plant-level panel data covering a period from 1979 to 1996, during which Canada experienced large exchange rate fluctuations and tariff reductions. We make use of Statistics Canada's *Annual Survey of Manufacturers* (ASM), which allows for a rich set of covariates with regard to nationality, export intensity, and industry characteristics. As a result, we are able to examine the heterogeneity of responses of different subgroups of plants to changing tariffs and exchange rates. The paper also looks at the problems associated with interactions in probit regression and offers correct interpretation of the effects of interaction terms between tariffs/exchange rates and producer characteristics.

Section 1 reviews a set of hypotheses regarding plant exit using a variety of models from the industrial-organization and international-trade literature. Section 2 introduces the data sources used herein and provides summary statistics. Section 3 outlines empirical specifications, and presents empirical results. Section 4 concludes.

1. A number of studies (Head and Ries 1999, Fung 2008) have looked at how changes in exchange rates affect the scale of production. Using a panel of 230 Canadian manufacturing industries between 1988-1994, Head and Ries (1999) find that the overall growth in average output per plant is due to undercounting of small establishments, changes in the industry composition, exchange rate depreciation, and U.S. tariff reductions. Fung (2008), however, finds that real-currency appreciations lead to scale expansion of surviving firms in Taiwanese manufacturing plants. Baggs *et al.* (2009) examine the issue of exchange rate and firm survival, but differ from this paper in terms of data, sample period, methodology and findings.

1 Analytical Framework

This section draws upon theoretical and empirical work on plant exit from both the industrial-organization and international-trade literature, and outlines a set of testable hypotheses that we will examine in the following sections.

1.1 Plant death and exchange rate

Very little work has been done on the relationship between plant exit and changes in exchange rates, either theoretically or empirically. Here we make use of the recent heterogeneous-firm model of trade developed by Bernard *et al.* (2003) and Melitz and Ottaviano (2008).

Bernard *et al.* (2003) adapt the Ricardian model to firm-specific comparative advantage. The authors calibrate their model to U.S. plant-level statistics and U.S trade data. Using this model, they simulate and obtain comparative statistics on the impacts of globalization and dollar appreciation on productivity and plant entry and exit in the U.S. manufacturing sector. They found that U.S-dollar appreciation raises U.S manufacturing productivity. Part of the gain in aggregate productivity is due to the exiting of less productive domestic producers.[2]

Melitz and Ottaviano (2008) develop a monopolistically competitive model of trade with heterogeneous firms producing a horizontally differentiated good with a single production factor of labour in a general equilibrium setting. Firms are heterogeneous in terms of efficiency, and markets differ with respect to the "toughness" of competition in terms of the number and average efficiency level of competing firms. Higher efficiency is modeled as producing a greater variety at lower marginal cost. A critical cut-off cost threshold is determined when firms earn zero profit. An entering firm would immediately exit if its profit level were negative (with above-cut-off cost).

Trade is related to the toughness of competition in a product market, which then feeds back into the selection and reallocation of heterogeneous domestic producers and exporters in that market. A unilateral liberalization by the home country (a tariff cut at home, holding tariffs at foreign-country constant) increases import competition at home and generates a decrease in its threshold cost cut-off, forcing some of the less efficient plants at home to shut down.

The Melitz and Ottaviano (2008) model with asymmetric trade costs can be used to predict the effects of exchange-rate fluctuations on plant dynamics. An appreciation of a home currency is equivalent to lowering home tariffs and raising foreign tariffs. An appreciation represents decreased export-market opportunities on the export side and an increased level of import competition on the import side. It induces the least efficient plants to shut down operations. The opposite occurs when a currency depreciates.

2. The main channel for the productivity gain is the declining relative price of imported intermediates, which generates substitution of intermediates for labour and therefore productivity gain among surviving plants. Reallocation is also important: the gain from the exiting of less productive domestic producers is partially offset by the loss due to reallocation of production away from the most productive firms (which lose export markets).

Both the Bernard *et al.* (2003) and Melitz and Ottaviano (2008) models lead to:

> Hypothesis 1: An appreciating currency increases the exit rate of less productive plants. In other words, the effect in terms of plant death is not distributed equally across plants: changes in the real exchange rate have a stronger effect on the survival of the least efficient plants. This suggests a significant interaction effect between exchange-rate movements and the efficiency level of a plant.

1.2 Plant death and symmetric tariff reductions

The heterogeneous-firm-based models of international trade (Melitz and Ottaviano 2008; Bernard *et al.* 2003; Yeaple 2002; Melitz 2003; Baldwin and Gu 2009) all generate the equilibrium property that a symmetric reduction in bilateral tariff reductions forces the least efficient firms to exit. Exporters are less likely to fail than non-exporters, as a result of the higher efficiency of the former.

A number of papers have investigated the effects of declining tariffs on industry dynamics (Head and Ries 1999; Gu *et al.* 2003; Lileeva 2008). They find that a fall in Canadian tariffs increased exit rates of Canadian firms. Bernard, Jensen, and Schott (2003) further find evidence supporting the major hypotheses of the heterogeneous-firm models. They find that low-productivity non-exporters are more likely to die and that declines in trade costs increase the probability of death. Pérez *et al.* (2004) find that exporting firms enjoy better survival prospects.

> Hypothesis 2: Falling tariffs force the least efficient firms to exit. In other words, a fall in tariffs is expected to have a stronger effect on the death of a plant that is least efficient. This suggests a significant interaction effect between tariff cuts and the efficiency level of a plant.

> Hypothesis 3: Non-exporters, compared to exporters, are more likely to die as a result of the lower efficiency of the former.

1.3 Plant death and other risk factors

There has been a profusion of theoretical and empirical work in the industrial-organization literature on entry and exit of firms. One stylized fact (Dunne 1988; Baldwin 1995; Geroski 1995; Baldwin *et al.* 2000) is that size and age are positively related to a plant's probability of survival. Both the "liability of newness" effect (Stinchcombe 1965) and the selection models (Jovanovic, 1982; Pakes and Ericson 1998) suggest that new entrants and smaller plants are at a greater risk of failure compared with older and larger plants. New plants go through a process of learning after entry. This involves solving a range of problems, from acquiring suitable capital, to training a new workforce, establishing an appropriate organizational structure, and establishing upstream and downstream links with suppliers and customers (the "liability of newness" effect). New plants tend to be small relative to the minimum efficient scale; the likelihood of survival for small firms is lower because they are confronted by a scale cost disadvantage (the "selection" effect). Unlike large plants, small plants may not have ready access to capital and labour markets;[3] this in turn increases operating costs and their chances of exit.

3. See Johnson, Baldwin, and Hinchley (1997), and Baldwin *et al.* (2002), for a study of financing issues in new firms.

Hypothesis 4: Younger plants are more likely to die.

Hypothesis 5: Smaller plants are more likely to die.

In addition to the effect of age and size on plant exit, selection models by Jovanovic (1982) and Ericson and Pakes (1995) also suggest that low-productivity plants have a higher probability of exit. Jovanovic's (1982) model is based on passive learning. Entering plants do not know their efficiency levels before entering the market. After entry, new plants learn about their relative efficiency through natural selection. The less efficient plants exit, while the most efficient ones survive and grow. In contrast, in the models of Ericson and Pakes (1995) and Pakes and Ericson (1998), each firm's performance and survival are driven by firm-specific active learning and investments in R&D and in innovation activities.

Hypothesis 6: Less productive plants are more likely to die.

The relationship that should be expected between foreign ownership and plant exit is less clear. Various theoretical models have considered the role of foreign ownership with regard to the probability of plant exit. If foreign-owned subsidiaries have access to superior technologies, this would suggest that this group is more efficient and is less likely to exit. According to the resource-based view of firms (Wernerfelt 1984), the chances of survival depend to a large extent on a firm's ability to develop specific capabilities. On the one hand, multinationals are the type of firms that develop special-knowledge assets (Caves 2007) and have a greater propensity to be engaged in R&D, product innovation, and technological collaboration (Baldwin and Gu 2006); this may improve both their competitiveness and their chances of survival. On the other hand, in comparison with purely domestic plants, multinationals may have a higher elasticity of labour demand as a result of their enhanced ability to shift production across locations or outsource intermediate inputs from foreign plants (Riker and Brainard 1997; Brainard and Riker 1997). Since foreign multinational enterprises (MNEs) are less rooted in the local economy, they can shift their production to another country when the local economy deteriorates. The latter factors should increase the probability of shutdown, when faced with deteriorating domestic economic conditions.

The empirical evidence on foreign ownership and plant closure is mixed as well (Harris and Li 2007). For example, Bernard and Jensen (2002) find that plants owned by U.S. multinationals are more likely to close than similar plants of non-multinational firms. Görg and Strobl (2003) report a greater probability of exit for Irish plants that are foreign-owned. Li and Guisinger (1991) find that domestic entrants are more likely to exit than foreign ones.

Hypothesis 7: Foreign-owned plants may be either more or less likely to die compared with domestic-owned plants.

2 Data source and summary statistics

2.1 Data on real exchange rates

To investigate the impact of exchange-rate movements on plant survival, we use industry-specific real exchange rates between Canada and the United States. The real exchange rate for industry *i* (E_i) is constructed as the normal exchange rate (*NER*, expressed in terms of U.S. dollars per Canadian dollar) deflated by U.S. (p_i^u) and Canadian industry (p_i^c) prices, respectively. That is: $E_i = NER\frac{p_i^c}{p_i^u}$. The nominal exchange rate is taken from Statistics Canada's CANSIM database. Canadian industry prices are from a database maintained by the Economic Analysis Division of Statistics Canada. They are gross output prices from the Input/Output system and cover 236 four-digit Canadian manufacturing industries from 1973 to 1997. The U.S. gross output prices are derived from the U.S. NBER-CES Manufacturing Industry Database, a joint effort between the National Bureau of Economic Research (NBER) and the U.S. Census Bureau's Center for Economic Studies (CES). The NBER-CES Manufacturing Industry Database covers 459 U.S. manufacturing industries from 1958 to 1996. They are matched and aggregated to the 236 Canadian manufacturing industries.

An alternative to constructing industry-specific real exchange rates is to calculate the exchange rate as a weighted average of exchange rates between Canada and its trading partners, with weights being the countries' trade shares for each industry (Baggs *et al.* 2009). There are two problems with the use of this rate for studies of firm reaction to movements in exchange rates. Firstly, the Canadian trade-weighted real exchange rates suffer from the lack of variability across industries since the United States is our predominant trading partner across manufacturing industries (this is indeed the case since, when year dummies are included, Baggs *et al.* (2009) find that real exchange rates tend to have an insignificant impact). Secondly, this rate assumes same price adjustments to nominal exchange-rate movements across industries. However, Baldwin and Yan (2007) find large heterogeneity in industries' responses. The price-adjusted real exchange rate is a better indicator of an industry's international competitiveness. It measures the price spread between an industry's product price and the landed price charged by industries in other countries. International competitiveness is affected not only by the nominal exchange rate but also by domestic and foreign price movements. For example, if the Canadian dollar appreciates against the U.S. dollar (an increase in NER) but this is offset by movements in the relative inflation rate of Canada (a decrease in $\frac{p_i^c}{p_i^u}$), there is no change in the competitive pressure faced by Canadian firms as a result of the exchange-rate movement. What is relevant to competitive pressures is the movement in relative domestic prices in each country. Changes in the nominal exchange rate have a potential impact only in respect of an industry's competitiveness. The actual shifts in competitiveness depend on the ability and the speed with which the industry adjusts its prices to changes in the nominal exchange rate.[4] When the real exchange rate increases, Canadian manufacturers are placed under more pressure by U.S exporters as they lose competitiveness. When the real exchange

4. Baldwin and Yan (2007) examine factors affecting relative price movements in response to nominal-exchange-rate changes and find large heterogeneity in industries' responses.

rate experiences a downward trend, Canadian industries become more competitive relative to their foreign counterparts.

The Canadian dollar has gone through several cycles of appreciation and depreciation relative to U.S. dollar. It first appreciated in the early 1970s after a period of a fixed exchange rate against the U.S. dollar. It depreciated between the mid-1970s and mid-1980s; this depreciation was followed by an appreciation in the late 1980s. The Canadian dollar then experienced a long period of depreciation over almost the entire decade of the 1990s; since 2002, the Canadian dollar has appreciated considerably, from US$0.64 in 2002 to US$0.93 in 2007. Chart 1 plots the nominal and real exchange rates for the manufacturing sector from 1960 to 2007, using Canadian and U.S. manufacturing GDP deflators for the real exchange rate.[5] Prices are all indexed to 1961. The real exchange rate for the manufacturing sector tracks the movement of the nominal exchange rate, indicating the stickiness of Canada/U.S. prices. Prices do not adjust to movements in the nominal exchange rate immediately.

We divide the entire period 1979-1996 into three sub-periods: 1979-1984; 1984-1990; and 1990-1996. They roughly correspond to the depreciation and appreciation cycles of the Canadian dollar. They also roughly correspond to the periods preceding and the periods following the *Free Trade Agreement between Canada and the United States of America* (FTA between Canada and the United States), which came into force in 1989, and the *North American Free Trade Agreement* (NAFTA), which came into force in 1994.

Summary statistics of exchange-rate changes over the three periods are provided in Table 1. The Canadian dollar depreciated at an average annual rate of 1.63 percentage points between 1979 and 1984, and at an average annual rate of 2.06 percentage points from 1990 to 1996, against the U.S. dollar. It appreciated at an annual average rate of 1.42 percentage points from 1984 to 1990. The average real exchange rate over 236 manufacturing industries experienced a pattern of movements similar to that for the nominal exchange rate. The standard deviations for the real exchange rate are large, indicating substantial variations across industries. In the next section, we investigate how plant survival differs systematically with changes in real exchange-rate movements across industries.

2.2 Data on tariff reductions

The Canadian manufacturing sector has also had to adapt to increasing trade liberalization. The Kennedy, Tokyo, and Uruguay rounds of international-trade liberalization led to falling tariffs in the 1960s, 1970s, and 1980s. The FTA and NAFTA followed up with even larger tariff reductions than had been experienced in previous decades.

To investigate the effect of tariff reductions on plant survival, we use bilateral tariffs between Canada and the United States as our measure of trade costs. More specifically, we use the average of Canadian tariff reductions against U.S. imports and U.S. tariff reductions against Canadian exports.[6] Data on Canadian tariffs against the U.S. and on U.S. tariffs against Canada are available from 1980 to 1996 for 236 four-digit manufacturing industries.[7] The data are constructed on the basis of import duties by commodity. Commodities are linked to their primary

5. Post-1996, the U.S. data are taken from the EU KLEMS database.
6. Previous work has found that, at the industry level, correlations in tariff changes across the two countries are sufficiently high as to make it difficult to discern separate effects of reductions in tariffs in each country on structural changes in Canada (Baldwin, Caves, and Gu 2005).
7. Tariff data for 1980 are used for 1979.

industries of production. Average industry tariffs are then calculated using import values as weights.[8]

Table 1 shows that tariff reductions between Canada and the U.S. are large, at an annual average rate of 0.22 percentage points during 1979-1984, 0.33 percentage points during 1984-1990, and 0.62 percentage points during 1990-1996.

2.3 Data on plants

The plant-level data come from Statistic Canada's ASM database, a longitudinal database that tracks Canadian manufacturing plants over time.[9] It has information on shipments, value-added, employment, age of plants, nationality of ownership control, exports, and industry affiliation at the 1980 four-digit Canadian Standard Industrial Classification. Information on export status is available only for 1979, 1984, 1990, 1993, 1996, and 1997 for plants that filled out the long form.[10] Exits are defined for the purposes of this study as plants that completely cease to report any data.[11]

Table 2 contains sample statistics for plant characteristics. The number of plants in manufacturing increased slightly over time, from 34,000 in 1979, to 38,000 in 1984, and to 42,000 in 1990. Distributions of plant characteristics are skewed. For example, the majority of plants have lower labour productivity than the mean. The same is true of plant size. Over the entire period, around 65% of plants had a value of labour productivity that was below the four-digit industry average, and around 74% of plants had a labour employment that was below the industry average. A small percentage of plants were exporters (16%). On average, foreign-controlled plants accounted for 14% of all plants. The number of foreign-controlled plants decreased steadily over time, from 16.2% in 1979, to 13.8% in 1984, and to 12.3% in 1990. At the same time, the number of exporters increased from 13.1% in 1984 to 21% in 1990; this increase coincided with the coming into force of the FTA between Canada and the United States, in 1989.

We also find that plant turnover increased. The incidence of plant exits increased from 31.2% in the 1979-to-1984 period to about 37% in the latter two periods. Most exiting plants were small; their output shares accounted for only about 11% over the three periods. There are major differences between the characteristics of exiting and those of continuing plants (Table 3). Over the three periods, exiting plants were less productive, smaller, younger, and more likely to be non-exporters and domestic-controlled plants than continuing plants.

There are also major differences in the characteristics of exporters and non-exporters, and between those of domestic- and foreign- controlled plants (Table 4). Exporters and foreign-controlled plants accounted for an average of 16% and 14% of all Canadian manufacturing

8. We are grateful to Alla Lileeva for providing us with the tariff data. For details on the sources and construction of the tariff data, see the Appendix in Trefler (2004).
9. Over the study period, the 'survey' was essentially a census, with data on smaller firms being filled with administrative records.
10. The survey data are derived from long-form questionnaires (often given to larger plants) and short-form questionnaires (often given to smaller plants). The long-form questionnaires contain much more detailed information than do the short-form questionnaires. Implicit in our analysis is the assumption that small plants (which filled in the short-form questionnaires) are non-exporters. The assumption is reasonable. According to a 1974 survey that collected export data on all plants, only 0.4% of plants that filled in the short-form questionnaires reported exports (Baldwin and Gu 2003).
11. Plants that temporarily stop reporting data but shortly thereafter start doing so again are not classified as plant deaths here.

plants, respectively. Exporters and foreign-controlled plants were more productive, larger, and older than non-exporters and domestic-controlled plants.

3 Empirical specification and results

Building on existing trade models involving heterogeneous firms (Melitz and Ottaviano 2008; Melitz 2003; Bernard *et al.* 2003; Baldwin and Gu 2009), we summarize a plant's decision to exit with:

$$\Pr(Exit_{pt} = 1) = \Pr(c_{pt} \succ c^*) \tag{1}$$

where c^* is the critical cost cut-off threshold, at which point a plant earns zero expected profit. A plant is hypothesized to exit if its cost c_{pt} at period t is more than the threshold and thus the plant earns negative expected profit.

We further assume that the cost level of a plant depends on a combination of plant characteristics, industry shocks relating to tariff reductions, and the real exchange rate, as well as the interactions of these factors. That is:

$$c_{pt} = x\beta = \alpha_0 + \delta\Delta V_{it} + \phi Z_{pt_0} + \lambda\Delta V_{it} Z_{pt_0} \tag{2}$$

where β is a vector of coefficients $(\alpha_0, \delta, \varphi, \lambda)$ and x is a vector of independent variables that include a vector of industry-wide changes in tariffs and real exchange rates (ΔV_{it}), and a vector of plant-level characteristics at the beginning year of a period t_0 (Z_{pt_0}). Plant-level characteristics include relative labour productivity (relative to its four-digit industry average), relative plant size measured in terms of employment (relative to its four-digit industry average), and age. Note that changes in tariffs and real-exchange-rates are at four-digit industry level. They are treated as exogenous, rather than endogenous, or choice, factors, for each individual plant. While the real exchange rate depends on industry pricing decisions of the largest firms in each industry and might for some studies be considered endogenous, exit is primarily a phenomenon of small plants that take the pricing decisions of the large firms as given.

Accordingly, equation (1) is rewritten as

$$\Pr(Exit_{pt} = 1) = \Phi(x\beta) = \Phi(\alpha_0 + \delta\Delta V_{it} + \phi Z_{pt_0} + \lambda\Delta V_{it} Z_{pt_0}) \tag{3}$$

where Φ is the standard normal cumulative distribution.

Two econometric issues need to be addressed before we present results. Firstly, equation (3) could be estimated by using a fixed-effects model, which typically includes a set of year and industry dummies, in order to control for unobserved heterogeneity across plants and over time. An alternative to this common practice is to demean all variables.

We experimented with these two approaches. They produce exactly the same results when there are no interaction terms. With interactions, the two are almost, but not quite, the same.

This is because most statistical programs such as STATA would not know, for example, that the independent variable $\Delta v_{it} z_{pt_0}$ is an interaction term between Δv_{it} and z_{pt_0}. Including a set of period and industry dummies in the case of equation 3 is equivalent to subtracting the mean of $(\Delta v_{it} z_{pt_0})$ from the product of Δv_{it} and z_{pt_0} $(\Delta v_{it} z_{pt_0})$. This is not the same as the product of the demeaned Δv_{it} and z_{pt_0}, as it should be.

Even though the two approaches are essentially equivalent, the latter allows us to more easily interpret the marginal effects. We therefore adopt the demeaned approach. We demean variables Δv_{it} and z_{pt_0} before estimating equation (3). Period and two-digit industry specific averages are subtracted from these variables. (To be consistent with fixed-effects model, variable X_{it} is demeaned as follows: $x_{it} = X_{it} - \overline{X}_i - \overline{X}_t + \overline{\overline{X}}$, where x_{it} is the demeaned X_{it}, $\overline{X}_i$ is the average for each two-digit industry *i*, $\overline{X}_t$ is the average for each time period *t*, and $\overline{\overline{X}}$ is the average of $\overline{X}_i$ over all two-digit industries or the average of $\overline{X}_t$ over all time periods.) The interaction terms are the products of the demeaned variables Δv_{it} and z_{pt_0}.

Secondly, the inclusion of interaction terms makes the evaluation and interpretation of the results difficult and, in the past, has resulted in many incorrect estimates. Ai and Norton (2003) found that, among 72 articles published between 1980 and 1999 in 13 economics journals listed on JSTOR (a U.S.-based online system for archiving academic journals) that used interaction terms in nonlinear models, none of the studies interpreted the coefficient on the interaction term correctly. Since coefficients in probit models with interaction terms are hard to interpret (Ai and Norton 2003; Norton, Wang, and Ai 2004), we focus instead on the marginal effects when presenting results[12]. Marginal effects for interaction terms are calculated according to the following formulas:

$$\frac{\partial^2 \Phi}{\partial(\Delta v_{it})\partial(z_{pt0})} = \Phi'(x\beta)\frac{\partial^2(x\beta)}{\partial \Delta v_{it}\partial z_{pt0}} + \Phi''(x\beta)\frac{\partial(x\beta)}{\partial \Delta v_{it}}\frac{\partial(x\beta)}{\partial z_{pt0}} \tag{4}$$

The marginal effects of changes in tariffs and real exchange rates on plant exit are calculated as follows:

$$\frac{\partial \Phi(x\beta)}{\partial \Delta v_{it}} = \Phi'(x\beta)\frac{\partial(x\beta)}{\partial \Delta v_{it}} \tag{5}$$

Similarly, the marginal effects of plant characteristics on exit are calculated as follows[13]:

$$\frac{\partial \Phi(x\beta)}{\partial z_{pt0}} = \Phi'(x\beta)\frac{\partial(x\beta)}{\partial z_{pt0}} \tag{6}$$

12. Baggs, Beaulieu, and Fung (2009) who also examine the impact of exchange rates on survival are an example.
13. Marginal effects in equations (4)-(6), and differences in marginal effects, can be obtained by using the 'nlcom' or 'predictnl' command in STATA; this also calculates the standard errors of the marginal effects by the delta method.

3.1 Impact of tariff cuts on exit: all plants

We estimated equation (3) using a probit model. Marginal effects are reported in Table 6—and are based on the probit coefficient estimates reported in Table 5. Marginal effects are evaluated at industry mean values of all underlying variables. For all manufacturing plants, tariff cuts have a negative effect on exit that is statistically significant at the 1% level. A one-percentage-point reduction in tariffs increases the probability of exit by 4.7 percent. Further, the effect of tariff reductions on the probability of plant exit depends on the level of a plant's productivity: higher-productivity plants are less likely to die as a result of a given fall in tariffs since the marginal effect on the interaction term between tariff changes and productivity is positive and statistically significant at the 1% level. The interaction terms for the other variables are not statistically significant.

To demonstrate how marginal effects vary with plant characteristics, we graph the marginal effects of tariff changes across the observed range of relative productivity, relative employment, and age, respectively (Charts 2, 3 and 4).[14] The solid sloping line in Chart 2, for example, indicates how the marginal effects of tariff changes vary with relative productivity. Any particular point on this line is $\frac{\partial \Phi(x\beta)}{\partial \Delta v_{it}} = \Phi'(x\beta)\frac{\partial (x\beta)}{\partial v_{it}}$, where all *x*s—except relative productivity, which is allowed to vary—are evaluated at industry mean values. Ninety-five-percent confidence intervals around the line allow us to determine the points at which tariff reductions have a statistically significant effect on exit. The effect is significant whenever the upper and lower bounds of the confidence interval are either above or below the zero line.

These confidence intervals indicate that changes in tariffs have strong negative effects on the probability of exit when productivity is low. This negative effect declines as productivity increases. Once a plant's productivity is 1.6 times more than its industry average (or a plant's relative productivity deviates from the industry mean of one by 0.6 units as shown on the graph),[15] a change in tariffs no longer has a significant negative impact on plant death. This result is significant, since the productivity of roughly 88% of plants is less than 1.6 times the industry average. In other words, a fall in tariffs has a significant effect on the survival of 88% of manufacturing plants, whose productivity is less than 1.60 times the industry average. Within this group of plants, the negative effect of tariffs on death declines as productivity increases.

The marginal effects of tariff cuts are plotted against relative employment and age in Charts 3 and 4. A decline in tariffs has a significant impact on the survival of 84 percent of manufacturing plants—those whose employment is less than 1.60 times industry average employment, and on the survival of 82 percent of manufacturing plants, those that are either older than the average industry plant age or younger by not more than five years. Within these two groups of plants, the negative effect declines with employment size, but increases with age. However, as we will demonstrate in Table 7, this change in the negative effect of employment size and age is not statistically significant.

---

14. As a result of the skewed distribution of plants in terms of productivity and employment (many small and less productive plants and a few larger and very productive plants), the plots include only plants whose relative productivity and relative employment is within two standard deviations from their industry mean. This covers 98% of plants for Charts 2 and 5, and 97% of plants for Charts 3 and 6. Charts 4 and 7 includes all plants.
15. All variables are measured as deviations from two-digit industry means. For example, relative productivity has a mean value of one; for a plant whose productivity is twice as much as the industry average, the relative productivity is two, and its deviation from the mean of relative productivity is one.

The marginal effects are calculated in Table 6 by relative labour productivity, relative employment, and age quartiles. The marginal impacts in these quartile groups are evaluated at the mean of all variables—except the variable used to classify quartiles, which is evaluated at quartile mean values. As was found in Charts 2, 3 and 4, a reduction in tariffs significantly increases the exit rate for plants in the lowest three quartiles, defined in terms of productivity and employment, but has no significant impact for plants in the highest quartiles. In addition, the marginal effect drops as productivity or employment moves from the lowest quartile to the highest quartile. In particular, the differences among the four quartile groups in terms of productivity are significant at the 5% level, but insignificant among the four quartile groups in terms of employment. Tariff reductions impact on plant survival for all age groups, but are marginally significant only for the youngest group, and the differences among the four groups are not statistically significant.

In sum, we find tariff reductions have strong negative effects on the probability of plant exit. A fall in tariffs increases the likelihood of exit for around 80 percent of manufacturing plants with relatively low productivity. Within this group of plants, the negative effect declines as productivity increases. This supports hypothesis 2.

3.2 Impact of real exchange-rate changes on exit: all plants

Changes in the value of the Canadian dollar have a significant positive impact on plant exit. A one-percentage-point appreciation in the Canadian dollar raises the probability of exit by 0.3 percent, statistically significant at the 5% level. Furthermore, the effect of real-exchange-rate changes on plant exit depends on the level of productivity: higher-productivity plants are less likely to die as a result of a given appreciation of the Canadian dollar since there is a negative marginal effect associated with the interaction term between real-exchange-rate changes and productivity that is statistically significant at the 1% level. The interaction terms for the other variables are not statistically significant (Table 7).

Marginal effects of changes in the real exchange rate are plotted against relative productivity, relative employment, and age, respectively in Charts 5, 6 and 7). Changes in the real exchange rate have strong positive effects on plant exit when productivity is low (Chart 5). This positive effect declines as productivity increases. Once a plant's productivity is 1.1 times more than its industry average (or a plant's relative productivity deviates from the industry mean of one by 0.1 units as shown on the graph), changes in the real exchange rate no longer have a significant positive impact on plant death. The result is substantive, since roughly 71% of plants have productivity that is less than 1.1 times the industry average. In other words, an appreciation of the Canadian dollar has a significant impact on the survival of 71% of manufacturing plants whose productivity lies below 1.1 times the industry average; furthermore, within this group of plants, the impact declines as productivity increases.

Marginal effects by the four quartiles in terms of productivity (Table 7) further confirm the results from Chart 5: an appreciation in the Canadian dollar significantly increases the exit rate for plants in the lowest three quartiles, but has no significant impact for plants in the highest quartile. The marginal effect drops as productivity moves from the lowest to the highest quartile; the differences among the four quartiles are statistically significant at the 5% level.

Not all characteristics are related to the impact of exchange-rate fluctuations. The marginal impact of fluctuations in the Canadian dollar on plant closure does not vary significantly across plants that differ in terms of employment size or age (Charts 6, 7 and Table 7).

In sum, we find that the value of the Canadian dollar has a strong positive effect on the probability of plant exit. An appreciation of the Canadian dollar increases the likelihood of plant failure for around 70 percent of manufacturing plants with relatively low productivity. Within this group of plants, the positive effect declines as productivity increases. This supports hypothesis 1.

3.3 Impact of industry characteristics on exit: all plants

We confirm previous research findings that plant size, age, and productivity are important determinants of plant survival. Younger, smaller, and less productive plants are more likely to die since there are statistically significant marginal effects on the relative productivity, relative employment, and age variables (Table 8);[16] negative slopes are associated with these variables in Charts 8, 9 and 10. The results are consistent with predictions arising from hypotheses 4, 5, and 6.

3.4 Non-exporter vs. exporters

To examine how changes in tariffs and real exchanges rates differentially affect the survival of exporters and non-exporters, we estimate equation (3) separately for exporters and non-exporters. A plant is defined as an exporter if it exports at the beginning of a period. All variables are demeaned as was done previously. Probit coefficient estimates for both exporters and non-exporters are reported in Table 5.

The predicted exit rate for the two groups over the entire range of actual changes in tariffs and real exchange rates is plotted in Charts 11 and 12. Three conclusions can be drawn. First, tariff reductions are negatively associated with the predicted probability of exit for both exporters and non-exporters, while increases in the real value of the Canadian dollar are positively associated with the predicted probability of exit. This confirms our findings, reported in sections 2.1 and 2.2, that a fall in tariffs or a real appreciation in the Canadian dollar increases the probability of exit.

Second, the predicted exit rate for non-exporters is higher than the predicted exit rate for exporters[17]: 37.2 percent for non-exporters and 21.0 percent for exporters (Table 9). The marginal effect of being an exporter (the difference) is statistically significant at the 5% level. This supports hypothesis 3. Non-exporters are less efficient—less productive, smaller, and younger (Table 5). Their cost disadvantage leads to a higher probability of exit.

Third, the marginal effects of changes in tariffs and in real exchange rates on exit are significantly greater for exporters than for non-exporters—as is evidenced by the steeper slopes for exporters in Charts 11 and 12, and by the higher marginal effects calculated in Tables 6 and 7.[18]

16. Marginal effects are calculated on the basis of probit coefficients in Table 5, and evaluated at the two-digit industry mean values of all variables.
17. Predicted exit rates are evaluated at the common industry mean values of tariff cuts and real-exchange-rate changes, and at group-specific industry mean values of productivity, employment, and age.
18. To compare the difference in how a given shock in tariff cost and exchange rate affects exporters and non-exporters, we evaluate the marginal effects by holding changes in tariff cost and exchange rate constant across the two groups (evaluated at the common two-digit industry mean values).

When an exporter and a non-exporter have similar efficiency levels in terms of productivity, size, and age (i.e., controlling for plant characteristics by evaluating marginal impacts at the common industry mean values of relative productivity, relative employment, and age), changes in tariffs and real exchange rates have a greater impact on the exit probability of the exporter: the marginal effects are -10.0 percent and 1.1 percent respectively for exporters, compared with -3.7 percent and 0.1 percent for non-exporters. The difference between them is statistically significant (Tables 6 and 7).

Since exporters are more efficient than non-exporters, we expect that, after allowing for varying group characteristics by evaluating marginal impacts at the group-specific industry mean values of relative productivity, relative employment, and age in order to take into account efficiency levels, the effect on the exit of exporters will be reduced and the effect on the exit of non-exporters will be increased. As expected, we find that the marginal impacts are reduced to -7.0 percent and 0.8 percent, respectively, for exporters, but increased to -3.9 percent and 0.2 percent, respectively, for non-exporters. The effect on exporters, however, remains significantly greater than the effect on non-exporters (Tables 6 and 7). This suggests that, besides the differences in efficiency levels as measured by the variables included here, exporters and non-exporters differ in other important ways that make the survival of exporters more sensitive to changes in tariffs and real exchange rates than the survival of non-exporters. It follows that one should not infer from the heterogeneous firms' models that a fall in trade costs increases the likelihood of plant exit for non-exporters more than for exporters simply because non-exporters are at the lower end of productivity distribution. The productivity or efficiency level of a plant as measured by productivity is not the only factor determining the survival of plants. There are other important differences between exporters and non-exporters that are not captured by the efficiency characteristics used in the analysis. One possible explanation is that international-oriented plants such as exporters face more intense competition than do domestic-oriented plants such as non-exporters. Exporters, by their very nature, are in a world where changes in tariffs and the exchange rate immediately affect their profit margin and therefore the likelihood of their survival. They may also have different cut-offs that lead to more rapid adjustment.

Other evidence suggests that exporters and non-exporters respond differently to changes in trade costs. Baldwin and Gu (2009) examined the impact of tariff reductions on the length of production runs and found that exporters were more likely to increase their production runs and exploit scope economies than were non-exporters over the 1990s. These two results suggest that changes in tariffs and in real exchange rates generate more turnover and adjustment among exporters than among non-exporters, and it is possible that these factors have a greater effect on both the death rate and the birth rate—but additional research is required here.

The above results indicate that exporters are more sensitive than non-exporters to changes in tariffs and real exchange rates. We further show that the higher-productivity plants of exporters are less likely to die, as evidenced by the positive and significant marginal effect on the interaction term between tariff changes and productivity (Table 6), and by the negative and significant marginal effect on the interaction term between real-exchange-rate changes and productivity (Table 7). The marginal effects by quartile set out in Tables 6 and 7, which show that differences in the marginal effects are significant across the four quartiles ranked in terms of productivity among exporters, further confirm this. We do not find a significant interaction effect for non-exporters.

In sum, we find that the predicted exit rate for non-exporters is much higher than the predicted exit rate for exporters, and that a fall in tariffs or an appreciation of the Canadian dollar increases the probability of plant failure for both exporters and non-exporters (but does so

significantly more for exporters). Among exporters, plants with low productivity are more likely to be affected. Our results suggest that exporters' deaths, in particular those of exporters with lower productivity, are driven largely by external changes in tariffs and in the real exchange rate, while the death of non-exporters is driven largely by their internal characteristics relating to their lower efficiency, which stems from their lower productivity, smaller size, or younger age.

3.5 Domestic-controlled vs. foreign-controlled plants

To examine how changes in tariff rates and in real exchange rates differentially affect the survival of domestic- and foreign-controlled plants, we estimate equation (3) separately for the two groups. A plant is defined as domestic- or foreign-controlled by its status at the beginning of a period. Probit coefficient estimates for both domestic- and foreign-controlled plants are reported in Table 5.

The predicted exit rate based on the estimated probit coefficients is plotted in Charts 13 and 14 for the two groups over the entire range of actual changes in tariff reductions and in the real exchange rate. Two conclusions emerge.

First, domestic-controlled plants have a higher probability of exit than foreign-controlled plants (Charts 13 and 14). The predicted exit rate is 35.7 percent for domestic-controlled plants, and 26.4 percent for foreign-controlled plants. The marginal effect of being a foreign-controlled plant (i.e., the difference) is statistically significant (Table 9). Foreign-controlled plants are more efficient, whether they derive their cost advantage from being more productive or larger, thus achieving economies of scale, or from being older, thus having absorbed expertise through more learning-by-doing (Table 4). That foreign-controlled plants are more likely to survive suggests that these plants are better endowed with specific superior capabilities that improve plants' competitiveness and survival.

Second, the marginal effects of changes in tariff rates and in real exchange rates on changes in the probability of exit are larger for foreign- than for domestic- controlled plants, as is evidenced by the steeper slopes for foreign-controlled plants in Charts 13 and 14, and by the marginal effects calculated in Tables 6 and 7.

When a domestic-controlled plant and a foreign-controlled plant have similar efficiency levels in terms of productivity, employment, and age, changes in tariffs and real exchange rates have a greater impact on the exit probability of the foreign-controlled plant: the marginal effects of tariffs and real exchanges rates are -10.0 percent and 0.7 percent, respectively, for foreign-controlled plants, compared with -4.6 percent and 0.2 percent, respectively, for domestic-controlled plants. The difference between them is statistically significant (Tables 6 and 7). One possible explanation is that a multinational has a greater capability, and thus a higher likelihood, to shift its production to another country whenever the domestic Canadian environment changes to its disadvantage. Another possible explanation is that multinationals are more sensitive to changes in profitability.

Since foreign-controlled plants are more efficient than domestic-controlled plants, we expect that, after their efficiency levels are taken into account, the effect on the exit of foreign-controlled plants will be reduced and the effect on domestic-controlled plants will be increased. As expected, we find that the marginal impacts are reduced to -5.8 percent and 0.5 percent, respectively, for foreign-controlled plants, but remain virtually unchanged for domestic-controlled

plants. As a result, the differences in the marginal effects between domestic-and foreign-controlled plants become insignificant (Tables 6 and 7). This suggests that the survival prospects of foreign-controlled plants are more sensitive to changes in tariffs and real exchange rates. The differential impact, however, becomes insignificant once we take into account differences in the efficiency levels, as measured here.

3.6 A counterfactual experiment

These results indicate that the impact of tariff reductions and real-exchange-rate changes on the likelihood of plant survival is statistically significant. To evaluate whether these impacts have economic significance, we conduct a counterfactual experiment. The counterfactual experiment proceeds as follows. First, we assume there were no changes in tariffs and real-exchange-rates, and calculate the corresponding predicted exit rate. The predicted exit rates under this case are caused by factors other than changes in tariffs and real exchange rates. Second, we calculate predicted exit rates by allowing actual changes in tariffs but holding changes in real exchange rates at zero. The difference in the predicted exit rates between case two and case one is the amount of failure induced by tariff changes. Third, we calculate predicted exit rates by setting changes in tariffs at zero but allowing actual changes in real exchange rates. The difference in the predicted exit rates between case three and case one is the failure resulting from changes in real exchange rates. Lastly, we allow actual changes in both tariffs and real exchange rates. The difference in predicted exit rates between case four and case one is the failure rates brought about by simultaneous changes in both tariffs and real exchange rates. In all cases, predicted exit rates are calculated using estimated coefficients in Table 5 and evaluated at the mean values of independent variables.[19]

3.6.1 All plants

The contribution of tariff cuts and real-exchange-rate changes to plant death are substantial. Results of the counterfactual experiment for all manufacturing plants are reported in Table 10. When there were no changes in tariffs and real exchange rates, the average predicted failure rate is around 25.3 percent over the three periods. The rate increased to an average of 34.3 percent when we allow actual changes in both tariffs and real exchange rates. Between 1984 and 1990, when the Canadian dollar appreciated against the U.S dollar, tariff cuts explain approximately 70 percent of the increase, while appreciation explains approximately 30 percent of the increase. During periods when the Canadian dollar depreciated (1979-1984 and 1990-1996), the increase in the predicted exit rate is attributable mostly to tariff reductions, but is partially offset by the depreciation of the Canadian dollar. During the implementation of NAFTA, in the 1990s, Canada experienced a substantial depreciation in its currency, which offset about 17% of the impact of falling tariffs during this period.

3.6.2 Exporters vs. non-exporters

We repeat the experiment for exporters and non-exporters. We confirm our previous findings that changes in tariffs and real exchange rates have a much greater incidence on the survival of exporters than on that of non-exporters.

Tariff cuts increase failure rates for both exporters and non-exporters, but more so for exporters. The difference is more prominent between 1990 and 1996, when there were deep tariff cuts

19. An alternative is to obtain the average predicted exit rates over all observations. The two methods yield very similar results.

under the FTA and NAFTA. During this period, tariff cuts induced an estimated failure rate of 21.2 percent for exporters, compared with 13.2 percent for non-exporters (Table 11).

The survival of exporters is at least twice as sensitive as that of non-exporters to fluctuations in real exchange rates. Between 1984 and 1990, when the Canadian dollar appreciated, plant exit induced by the appreciation is 4.6 percent for exporters, compared with only 1.6 percent for non-exporters. During periods when the Canadian dollar depreciated against the U.S dollar (1979-1984 and 1990-1996), the depreciation increases the likelihood of plant survival by 1.6 percent and 3.5 percent for exporters for the two periods, respectively, compared with 0.04 percent and 1.7 percent for non-exporters (Table 11).

3.6.3 Domestic- vs. foreign- controlled plants

Finally, we repeat the experiment for domestic- and foreign- controlled plants. We confirm our previous findings that changes in tariffs and real exchange rates have a much greater incidence on the survival of foreign-controlled plants than on the survival of domestic-controlled plants.

Tariff cuts induced higher failure rates for foreign-controlled plants than for domestic-controlled plants. The exception is the last period (1990-1996), when domestic-controlled plants underwent higher tariff cuts (3.5 percent) than did foreign-controlled plants (2.9 percent) during the period (Table 12).

The survival of foreign-controlled plants is about 2.3 times more sensitive than that of domestic-controlled plants to fluctuations in real exchange rates. Between 1984 and 1990, when the Canadian dollar appreciated, plant exit induced by the appreciation is 4.0 percent for foreign-controlled plants, compared with 1.7 percent for domestic-controlled plants. During periods when the Canadian dollar depreciated against the U.S dollar (1979-1984 and 1990-1996), the depreciation increased the likelihood of plant survival by 0.2 percent and 3.8 percent for foreign-controlled plants for the two periods, respectively, compared with 0.1 percent and 1.6 percent for domestic-controlled plants (Table 12) .

4 Conclusion

This paper examines the effect of tariff reductions and real-exchange-rate changes on plant death over a long period of tariff cuts and exchange-rate cycles. Included in the analysis is a set of factors that are hypothesized to affect plant closure: productivity; size; age; export and foreign-control status of plants; and changes in tariffs and real exchange rates. A probit model and a panel of Canadian manufacturing plants over the period of 1979-1996 are used to adduce empirical evidence on the simultaneous effect of tariff reductions and real-exchange-rate fluctuations on plant survival. Differences between exporters and non-exporters, and between domestic- and foreign- controlled plants, are also investigated.

Real-exchange-rate fluctuations are found to be strongly associated with plant shutdown, and the effect is significant both statistically and in terms of its impact on the economy. A real appreciation of the Canadian dollar relative to the U.S. dollar significantly increases the probability of plant death; a real appreciation of one percentage point in the currency value increases the likelihood of plant exit by 0.3 percent. Our counterfactual experiment indicates that this translates into a failure rate of 2.8 percent between 1984 and 1990, when the Canadian dollar appreciated by 9.4 percentage points; this represents an 11.6-percent increase from the

24.0-percent failure rate that we estimate for a situation where there are no changes in tariffs and real exchange rates. In contrast, the real depreciation of the Canadian dollar from 1979 to 1984 and from 1990 to 1996 significantly increases the probability of plant survival. During the implementation of NAFTA, in the 1990s, the Canadian economy experienced a substantial depreciation in its currency that offset about 17% of the impact of falling tariffs during this period.

The effect of exchange-rate movements on plant exit is not uniform across plants. When the real value of a currency appreciates, less efficient plants experience a greater probability of exiting. Similarly, when the real value of a currency depreciates, plants that are less efficient are more likely to survive.

Changes in tariffs are shown to be strongly associated with the likelihood of exit; the impact is statistically significant and substantial. The counterfactual experiment shows that, between 1990 and 1996, when extensive tariff cuts were effected under the FTA and NAFTA, tariff reductions induced a 15-percent failure rate, a 67.5-percent increase in the failure rates compared with the case when there were no tariff cuts. The impact is not felt equally across plants. Falling tariffs increase the likelihood of plant death, in particular, for plants that are less efficient.

Overall, for the periods examined, tariff reductions play a more important role in plant exits than do exchange-rate fluctuations. For the period 1984 to 1990, the magnitude of plant failure resulting from tariff reduction is around 2.6 times that of plant failure resulting from exchange-rate appreciation. The depreciation of the Canadian dollar over the period 1990-1996 led to a decrease in the exit rate, but this decline only partially offset the increased exit probability resulting from tariff cuts that occurred at the same time.

We find significant differences between exporters and non-exporters: the probability of exit is different; and they respond differently to changes in tariffs and real exchange rates. On the one hand, failure rates are much higher for non-exporters. They are less efficient, as a result of their being less productive, smaller, or younger. On the other hand, the survival probability of exporters is strongly affected by changes in tariffs and real exchange rates, much more so than that of non-exporters. The difference is statistically significant and substantial, whether or not we control for efficiency differences between exporters and non-exporters. The results indicate that the death of exporters, in particular exporters with lower productivity, is driven largely by changes in tariffs and exchange rates, while the death of non-exporters is driven mainly by the inherent characteristics that make them less efficient.

We also find significant differences between domestic- and foreign-controlled plants. On the one hand, failure rates are much higher for domestic-controlled plants. Domestic-controlled plants are typically less efficient; this is the result of their being less productive, smaller, or younger. On the other hand, the survival probability of foreign-controlled plants is affected to a greater extent by changes in tariffs and real exchange rates. However, once we take into account their efficiency differences, this differential impact becomes insignificant.

Our finding on the higher survival sensitivity of exporters and foreign-controlled plants to changes in tariffs and real exchange rates suggests that, besides the differences in efficiency levels, there are other important differences between exporters and non-exporters, and between domestic- and foreign- controlled plants, that are not captured by the efficiency characteristics used in the analysis.

Chart 1
Nominal and real exchange rate for manufacturing (1961=1)

index 1961=1

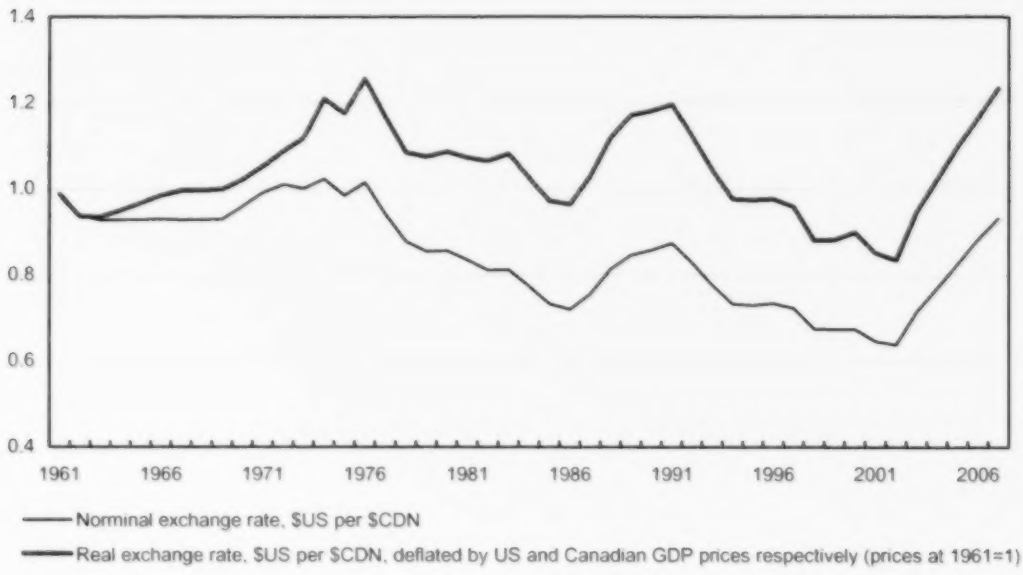
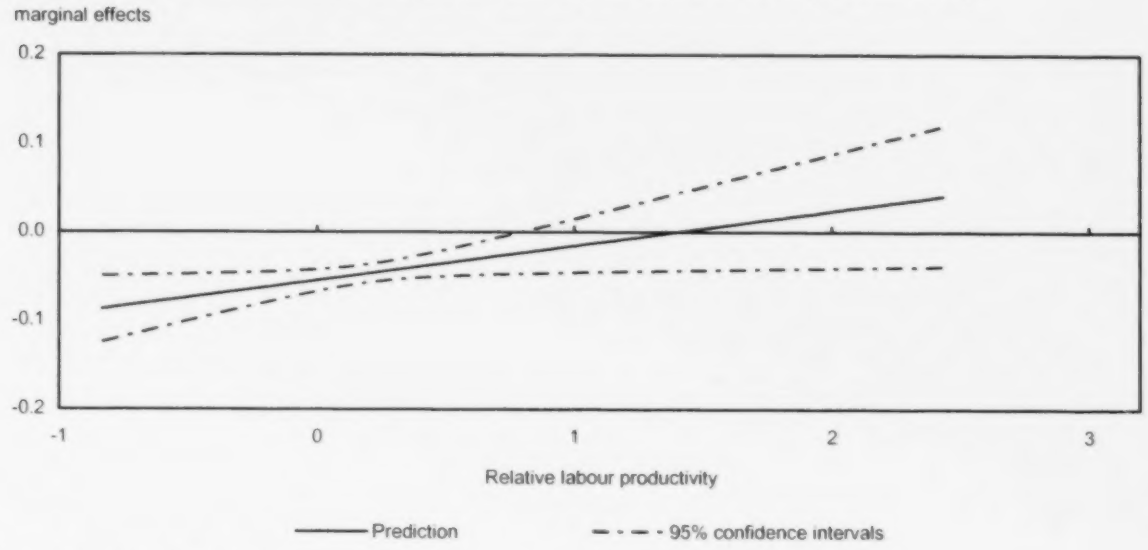
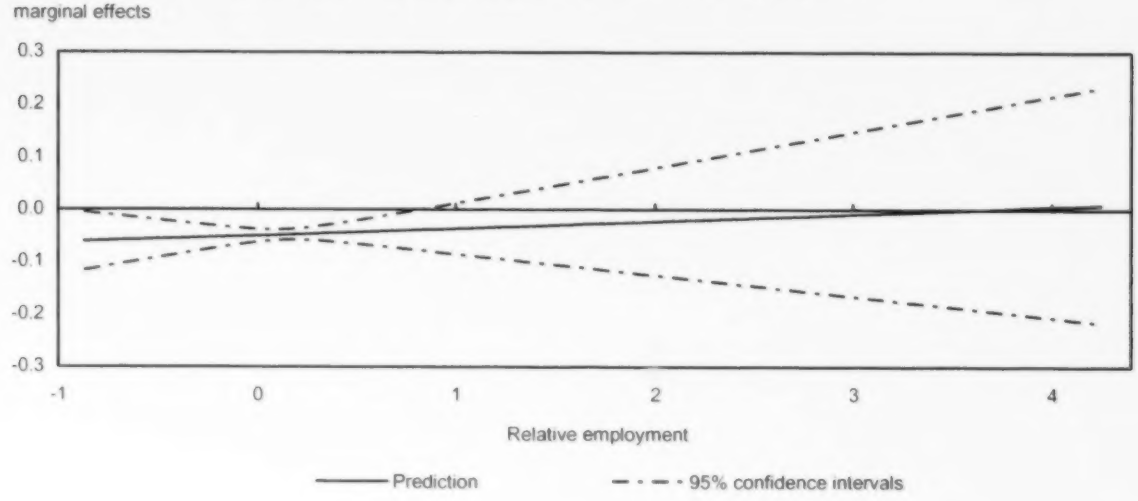


Chart 2
Marginal effects of tariff changes on exit by relative labour productivity



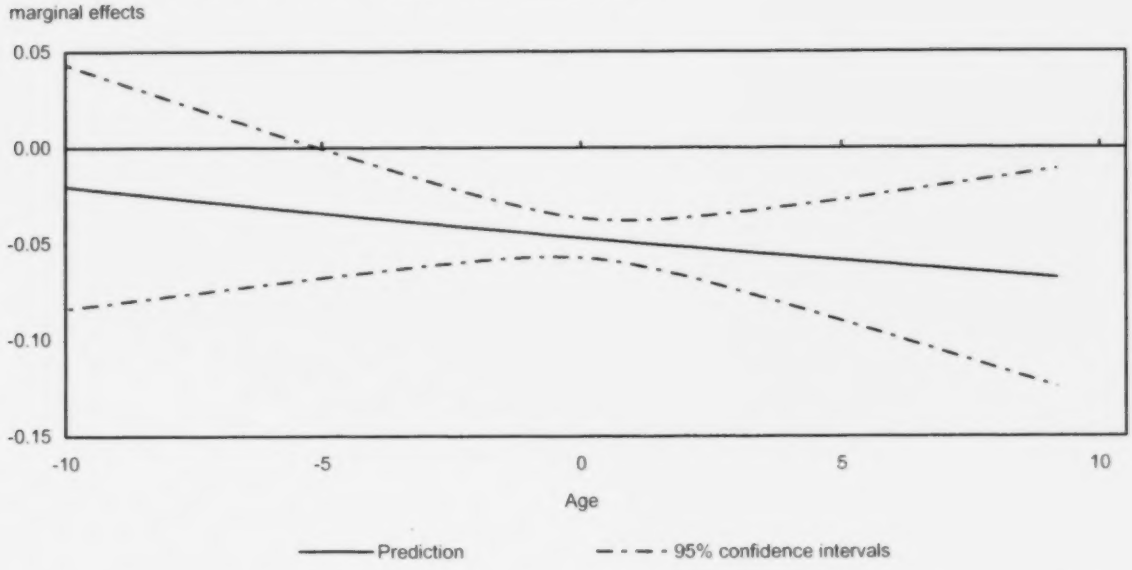
See note at the bottom of chart 4.

Chart 3
Marginal effects of tariff changes on exit by relative employment



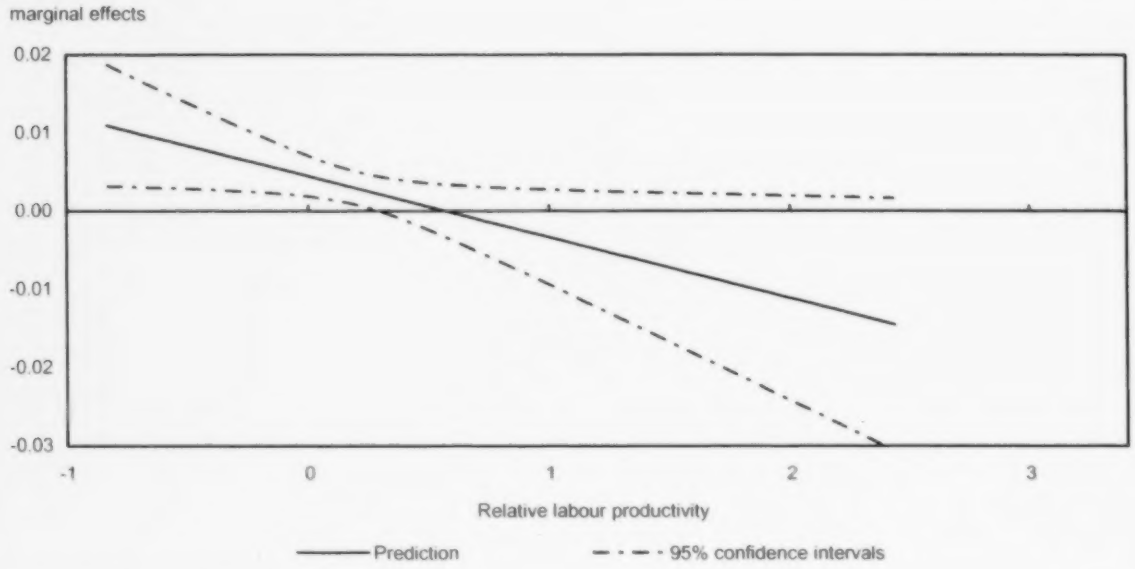
See note at the bottom of chart 4.

Chart 4
Marginal effects of tariff changes on exit by age



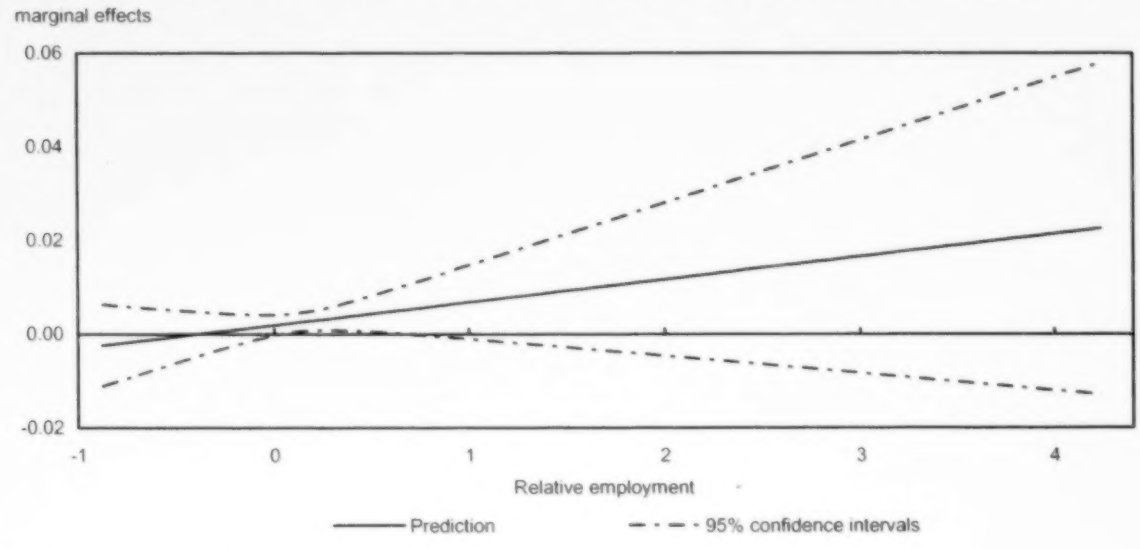
Note: As a result of the skewed distribution of plants in terms of productivity and employment (many small and less productive plants and a few larger and very productive plants), the plots include only plants whose relative productivity and relative employment is within two standard deviations from their industry mean. This covers 98% of plants for Charts 2, and 97% of plants for 3. Chart 4 includes all plants. All variables are measured as deviations from two-digit industry means. For example, relative productivity has a mean value of one; for a plant whose productivity is twice as much as the industry average, its relative productivity is two, and its deviation from the mean of relative productivity is one. Marginal effects are evaluated at industry mean values.

Chart 5
Marginal effects of real exchange rates changes on plant exit by relative labour productivity



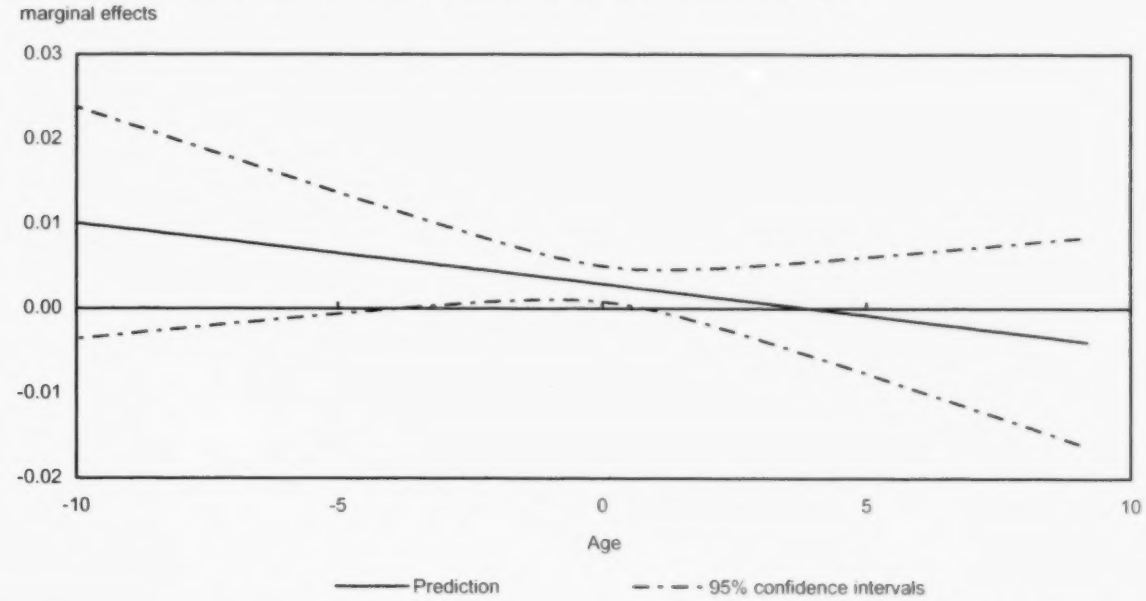
See note at the bottom of chart 7.

Chart 6
Marginal effects of real exchange rate changes on exit by relative employment



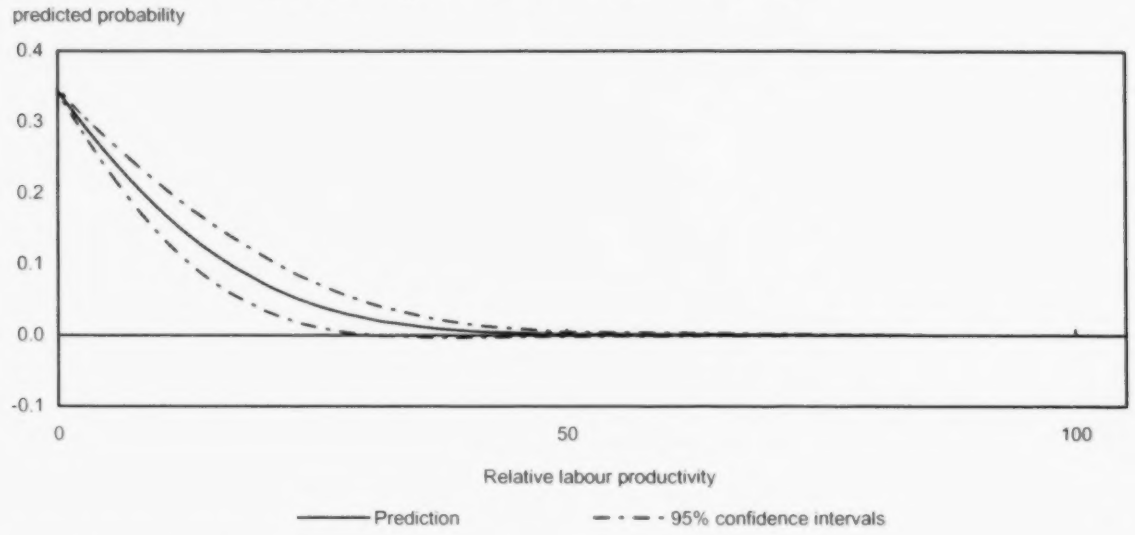
See note at the bottom of chart 7.

Chart 7
Marginal effects of real exchange rate changes on exit by age



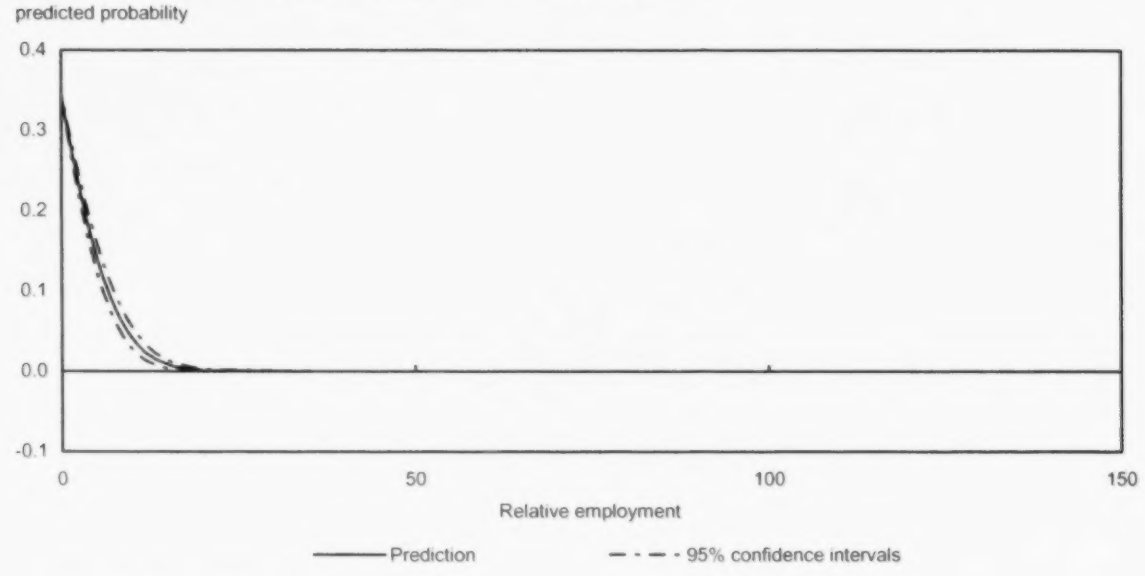
Note: Due to the skewed distribution of plants in terms of productivity and employment (many small and less productive plants and a few larger and very productive plants), the plots only include plants whose relative productivity and relative employment is within two standard deviations from their industry mean. This covers 98% of plants for Charts 5, and 97% of plants for 6. Chart 7 includes all plants. All variables are measured as deviations from 2-digit industry means. For example, relative productivity has a mean value of one; for a plant whose productivity is twice as much as the industry average, its relative productivity is two and its deviation from the mean of relative productivity is one. Marginal effects are evaluated at industry mean values.

Chart 8
Predicted probability of exit by relative labour productivity



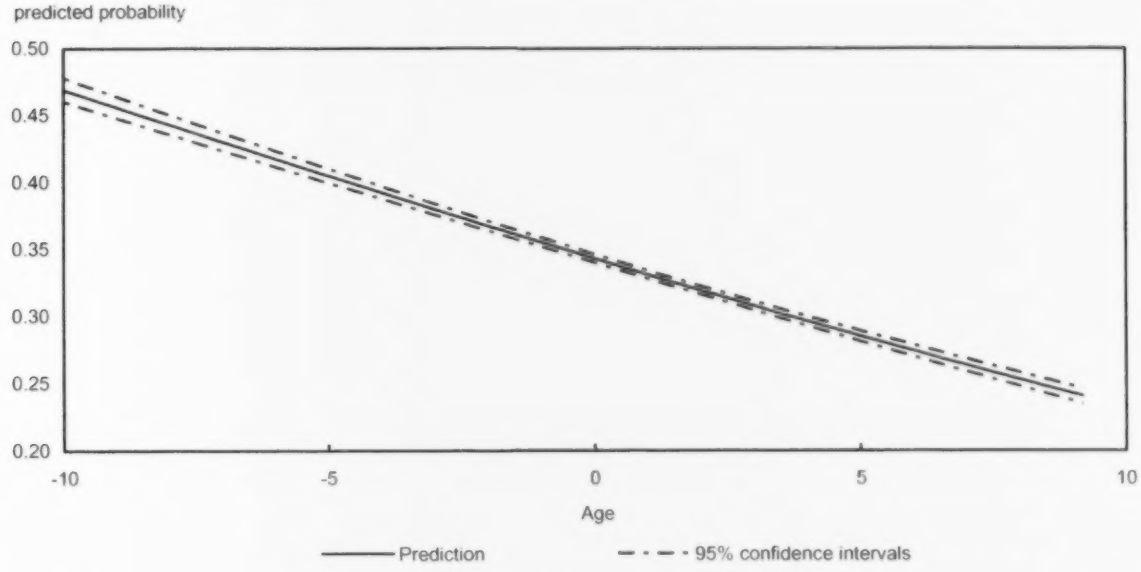
See note at the bottom of chart 10.

Chart 9
Predicted probability of exit by relative employment



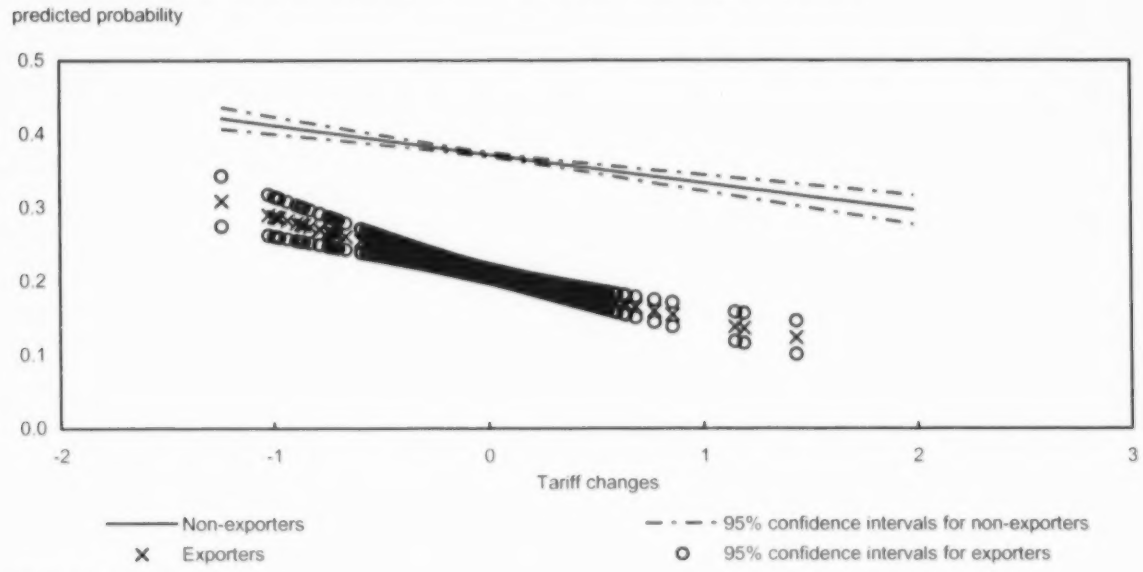
See note at the bottom of chart 10.

Chart 10
Predicted probability of exit by age



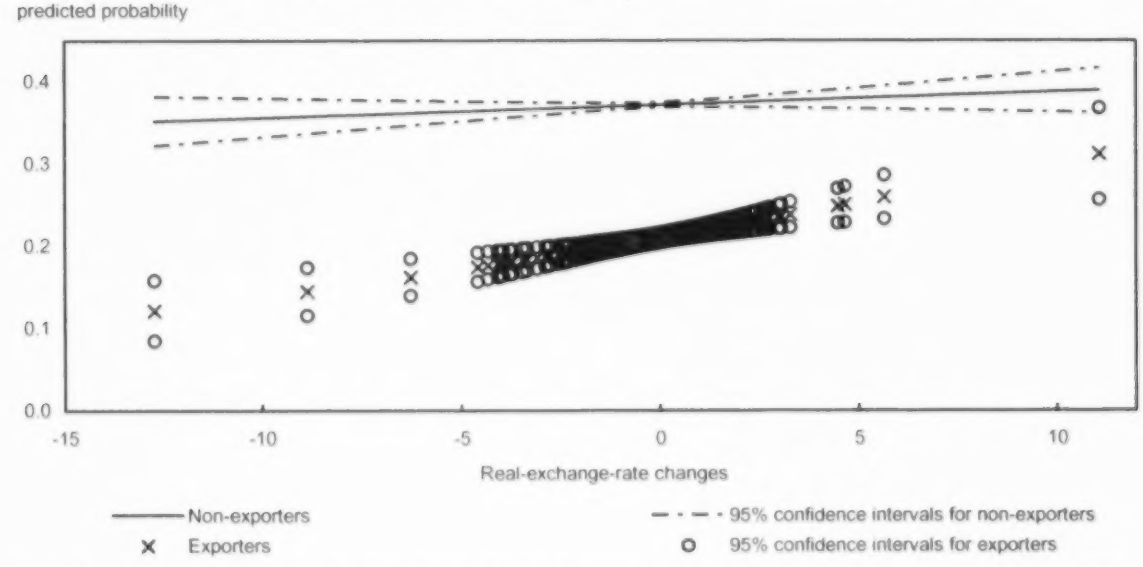
Note: All variables are measured as deviation from two-digit industry means. For example, relative productivity has a mean value of one; for a plant whose productivity is twice as much as the industry average, its relative productivity is two, and its deviation from the mean of relative productivity is one. Marginal effects are evaluated at industry mean values.

Chart 11
Predicted probability of exit by tariff changes and export status



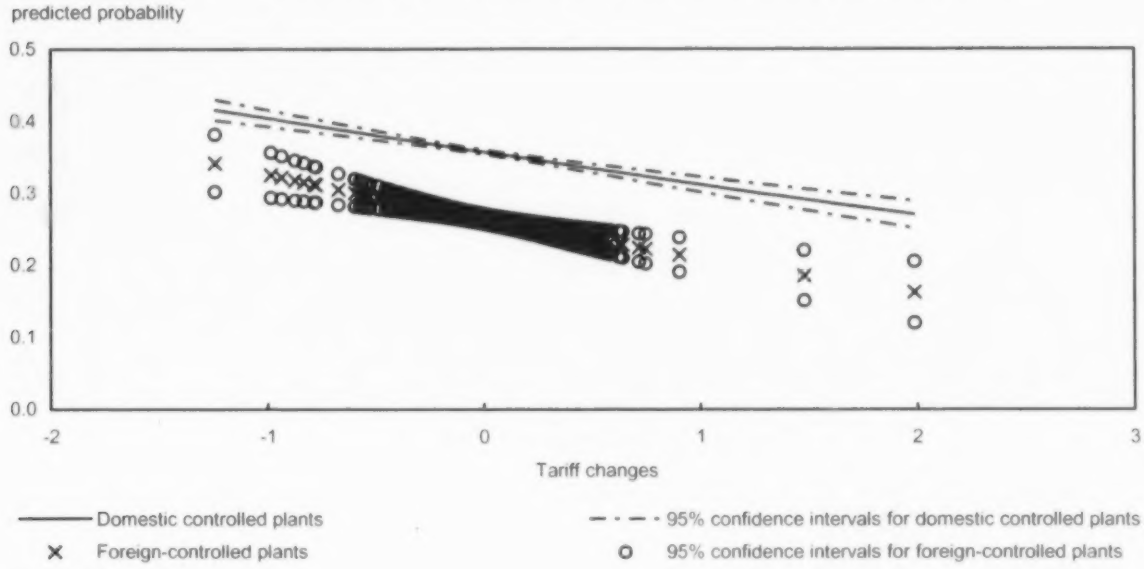
See note at the end of chart 12.

Chart 12
Predicted probability of exit by real-exchange-rate changes and export status



Note: All variables are measured as deviations from 2-digit industry mean values. Predicted exit rate is evaluated at the common 2-digit industry mean values of trade cost (Chart 11) or real exchange rate changes (Chart 12), and at group-specific 2-digit industry mean values of productivity, employment and age. The plots cover the entire range of actual changes in tariffs and real exchange rates.

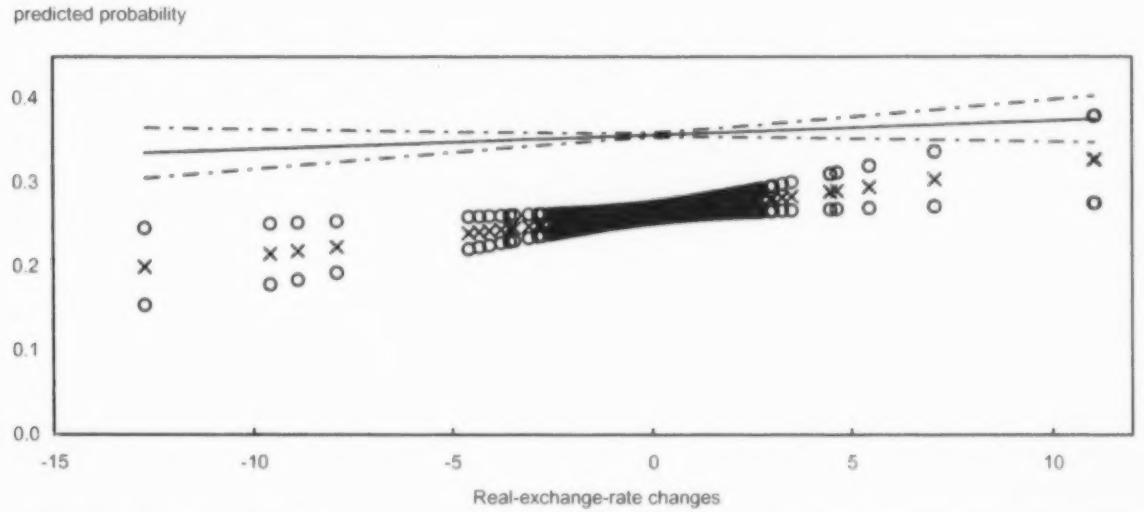
Chart 13
Predicted probability of exit by tariff changes and ownership control status



Domestic controlled plants
95% confidence intervals for domestic controlled plants
× Foreign-controlled plants
o 95% confidence intervals for foreign-controlled plants

See note at the end of chart 14.

Chart 14
Predicted probability of exit by real-exchange-rate changes and ownership control status



Domestic controlled plants
95% confidence intervals for domestic controlled plants
× Foreign-controlled plants
o 95% confidence intervals for foreign-controlled plants

Note: All variables are measured as deviations from two-digit industry mean values. Predicted exit rate is evaluated at the common two-digit industry mean values of trade cost (Chart 13) or real-exchange-rate changes (Chart 14), and at group-specific two-digit industry mean values of productivity, employment, and age. The plots cover the entire range of actual changes in tariffs and real exchange rates.

Table 1
Summary statistics of exchange rates and tariff changes

	1979 to 1984		1984 to 1990		1990 to 1996	
	Average annual changes	Standard deviations	Average annual changes	Standard deviations	Average annual changes	Standard deviations
			percent			
Nominal US/Canada exchange rate	-1.63	0.00	1.42	0.00	-2.06	0.00
Real US/Canada exchange rate	-0.19	2.06	1.57	1.54	-1.85	1.48
U.S. tariff against Canada	-0.20	0.34	-0.24	0.34	-0.39	0.43
Canadian tariff against US	-0.25	0.45	-0.42	0.53	-0.84	0.66
Average tariff between Canada and US	-0.22	0.30	-0.33	0.34	-0.62	0.51

Note: Average annual changes are calculated as differences between the first and last years of the variable, divided by the number of years. Tariffs for 1980 are used for 1979.

Table 2
Sample statistics, all plants

	1979 to 1984	1984 to 1990	1990 to 1996
Panel A, at the beginning of the period			
Number of all plants	34,000	38,000	42,000
		percent	
Plants with below-average labour productivity	65.4	63.6	66.9
Plants with below-average employment	74.7	74.6	73.4
Plants with below-average age	35.6	47.0	52.7
Exporters	13.0	13.1	21.0
Foreign-controlled plants	16.2	13.8	12.3
Panel B, during the period			
Exiting plants	31.2	37.5	36.6
Output of exiting plants	8.7	10.0	15.5

Note: Average productivity, average employment, and average age are averages for two-digit industries to which a plant belongs.
Source: Authors' calculation from the Canadian *Annual Survey of Manufacturers*.

Table 3
Summary statistics of continuing and exiting plants

	Continuing plants	Exiting plants
	number	
1979 to 1984		
Average relative labour productivity	104.2	90.8
Average relative employment	121.5	52.6
Age	4.6	3.7
	percent	
Non-exporters	83.8	94.0
Exporters	16.2	6.0
Domestic-controlled	81.1	89.7
Foreign-controlled	18.9	10.3
	number	
1984 to 1990		
Average relative labour productivity	105.4	91.1
Average relative employment	126.4	56.0
Age	7.5	5.8
	percent	
Non-exporters	82.8	93.8
Exporters	17.2	6.2
Domestic-controlled	84.2	89.4
Foreign-controlled	15.8	10.6
	number	
1990 to 1996		
Average relative labour productivity	105.0	91.4
Average relative employment	118.0	68.8
Age	9.4	7.2
	percent	
Non-exporters	76.1	84.0
Exporters	23.9	16.0
Domestic-controlled	87.4	88.2
Foreign-controlled	12.6	11.8

Note: Relative labour productivity and relative employment are measured as labour productivity and employment of a plant relative to its two-digit industry average.
Source: Authors' calculation from the Canadian *Annual Survey of Manufacturers*.

Table 4
Profiles of non-exporters vs. exporters, domestic vs. foreign-controlled plants

	Proportion of plants	Average relative labour productivity	Average relative employment	Average age
	percent		number	
All plants	100	100.0	100.0	6.7
By export status				
Non-exporters	84	93.2	75.0	6.2
Exporters	16	135.6	231.4	9.4
By ownership control status				
Domestic-controlled plants	86	97.2	86.5	6.4
Foreign-controlled plants	14	117.2	182.8	8.5

Note: Relative labour productivity and relative employment are measured as labour productivity and employment of a plant relative to its two-digit industry average. These are averages over three periods.
Source: Authors' calculation from the Canadian *Annual Survey of Manufacturers*.

Table 5
Probit coefficients

	All plants		Non-exporters		Exporters		Dummy for exporters	
	coefficient	standard error	coefficient	standard error	coefficient	standard error	coefficient	standard error
Variables								
Changes in tariffs	-0.128 *	0.014	-0.099 *	0.020	-0.313 *	0.040	-0.099 *	0.020
Change in real exchange rates	0.008 *	0.003	0.004	0.004	0.033 *	0.008	0.004	0.004
Relative productivity	-0.052 *	0.007	-0.052 *	0.008	-0.018 **	0.011	-0.052 *	0.008
Relative employment	-0.134 *	0.008	-0.155 *	0.013	-0.071 *	0.007	-0.155 *	0.013
Age	-0.033 *	0.001	-0.032 *	0.001	-0.017 *	0.002	-0.032 *	0.001
Change in tariffs × relative productivity	0.038 *	0.018	0.025	0.021	0.091 *	0.031	0.025	0.021
Change in tariffs × relative employment	0.010	0.028	0.013	0.046	0.038 **	0.023	0.013	0.046
Change in tariffs × relative age	-0.003	0.003	0.000	0.004	-0.007	0.007	0.000	0.004
Change in real exchange rates × relative productivity	-0.008 *	0.004	-0.003	0.004	-0.017 *	0.005	-0.003	0.004
Change in real exchange rates × relative employment	0.005	0.004	0.001	0.007	0.001	0.004	0.001	0.007
Change in real exchange rates × relative age	-0.001	0.001	-0.001	0.001	0.000	0.002	-0.001	0.001
Constant	-0.404 *	0.004	-0.383 *	0.006	-0.669 *	0.013	-0.383 *	0.006
Change in tariffs × dummy							-0.214 *	0.045
Change in real exchange rates × dummy							0.029 *	0.009
Relative productivity × dummy							0.033 *	0.013
Relative employment × dummy							0.085 *	0.015
Age × dummy							0.015 *	0.003
Change in tariffs × relative productivity × dummy							0.066 **	0.038
Change in tariffs × relative employment × dummy							0.026	0.052
Change in tariffs × relative age × dummy							-0.007	0.008
Change in real exchange rates × relative productivity × dummy							-0.014 *	0.007
Change in real exchange rates × relative employment × dummy							0.000	0.008
Change in real exchange rates × relative age × dummy							0.001	0.002
Constant × dummy							-0.286 *	0.014

	All plants	Non-exporters	Exporters	Dummy for exporters
Diagnostic statistics				
Number of observations	114,138	95,906	18,232	114,138
Log pseudolikelihood	-71,306	-61,655	-9,295	-70,950
Pseudo R-squared	0.0376	0.0307	0.0278	0.0424

See notes at the end of the table.

Table 5
Probit coefficients (concluded)

	Domestic-controlled plants		Foreign-controlled plants		Dummy for foreign-controlled plants	
Variables	coefficient	standard error	coefficient	standard error	coefficient	standard error
Changes in tariffs	-0.126 *	0.016	-0.285 *	0.044	-0.126 *	0.016
Change in real exchange rates	0.005	0.004	0.019 *	0.007	0.005	0.004
Relative productivity	-0.054 *	0.009	-0.057 *	0.011	-0.054 *	0.009
Relative employment	-0.147 *	0.010	-0.100 *	0.007	-0.147 *	0.010
Age	-0.034 *	0.001	-0.013 *	0.003	-0.034 *	0.001
Change in tariffs × relative productivity	0.040 *	0.020	0.008	0.041	0.040 *	0.020
Change in tariffs × relative employment	-0.018	0.035	0.099 *	0.026	-0.018	0.035
Change in tariffs × relative age	-0.004	0.003	0.014	0.009	-0.004	0.003
Change in real exchange rates × relative productivity	-0.004	0.006	-0.013 *	0.004	-0.004	0.006
Change in real exchange rates × relative employment	0.006	0.006	0.001	0.004	0.006	0.006
Change in real exchange rates × relative age	-0.001	0.001	-0.001	0.002	-0.001	0.001
Constant	-0.398 *	0.005	-0.516 *	0.011	-0.398 *	0.005
Change in tariffs × dummy					-0.159 *	0.047
Change in real exchange rates × dummy					0.014 **	0.007
Relative productivity × dummy					-0.004	0.014
Relative employment × dummy					0.047 *	0.013
Age × dummy					0.020 *	0.003
Change in tariffs × relative productivity × dummy					-0.032	0.046
Change in tariffs × relative employment × dummy					0.117 *	0.044
Change in tariffs × relative age × dummy					0.018 **	0.010
Change in real exchange rates × relative productivity × dummy					-0.009	0.007
Change in real exchange rates × relative employment × dummy					-0.005	0.007
Change in real exchange rates × relative age × dummy					0.000	0.002
Constant × dummy					-0.118 *	0.012

	Domestic-controlled plants	Foreign-controlled plants	Dummy for foreign-controlled plants
Diagnostic statistics			
Number of observations	98,172	15,966	114,138
Log pseudolikelihood	-62,104	-9,086	-71,190
Pseudo R-squared	0.0361	0.0354	0.0392

* p<0.05
** p<0.1

Notes: Standard errors correct for correlation across repeated observations on individual plants. All regressions are run with demeaned data (period- and two-digit industry- specific mean is subtracted from each variable). Data cells are left blank when variables are not included in the model.

Table 6
Marginal effects of changes in tariffs on plant exit

	All plants		Non-exporters		Exporters		Domestic-controlled plants		Foreign-controlled plants	
	estimate	standard error	estimate	standard error	estimate	standard error	estimate	standard error	estimate	standard error
Marginal effects of tariff changes										
After controlling for plant characteristics between groups	-0.047 *	0.005	-0.037 *	0.008	-0.100 *	0.013	-0.046 *	0.006	-0.100 *	0.015
Difference of being an exporter or a foreign-controlled plant					-0.063 *	0.015			-0.053 *	0.016
Allowing plant characteristics to vary between groups	-0.047 *	0.005	-0.039 *	0.006	-0.071 *	0.011	-0.046 *	0.005	-0.058 *	0.014
Difference of being an exporter or a foreign-controlled plant					-0.032 *	0.013			-0.012	0.015
By relative labour productivity quartile										
Quartile 1 (low)	-0.073 *	0.013	-0.058 *	0.015	-0.108 *	0.034	-0.068 *	0.013	0.001	0.050
Quartile 2[1]	-0.058 *	0.007	-0.048 *	0.009	-0.082 *	0.03	-0.055 *	0.007	0.008	0.029
Quartile 3[1]	-0.048 *	0.005	-0.041 *	0.008	-0.058 *	0.028	-0.045 *	0.005	0.011	0.024
Quartile 4 (high)[1]	-0.009	0.018	-0.015	0.022	0.035	0.039	-0.008	0.018	0.026	0.052
By relative employment quartile										
Quartile 1 (low)	-0.058 *	0.024	-0.052	0.037	-0.120 *	0.034	-0.032	0.029	-0.169 *	0.036
Quartile 2[2]	-0.056 *	0.019	-0.049 **	0.028	-0.112 *	0.031	-0.035	0.023	-0.151 *	0.032
Quartile 3[2]	-0.051 *	0.009	-0.044 *	0.011	-0.094 *	0.023	-0.042 *	0.010	-0.107 *	0.024
Quartile 4 (high)[2]	-0.020	0.058	-0.014	0.080	0.036	0.057	-0.072	0.066	0.215 *	0.067
By age quartile										
Quartile 1 (low)	-0.033 **	0.019	-0.043 *	0.017	0.025	0.061	-0.026	0.018	-0.093	0.063
Quartile 2	-0.039 *	0.011	-0.043 *	0.009	0.009	0.045	-0.035 *	0.010	-0.047	0.038
Quartile 3	-0.053 *	0.009	-0.041 *	0.015	-0.026	0.029	-0.054 *	0.011	0.029	0.028
Quartile 4 (high)	-0.056 *	0.013	-0.041 *	0.020	-0.039	0.037	-0.058 *	0.016	0.047	0.036
Marginal interaction effects										
Changes in tariffs × relative productivity	0.015 *	0.007	0.010	0.008	0.027 *	0.009	0.016 *	0.007	0.004	0.014
Changes in tariffs × relative employment	0.006	0.010	0.007	0.018	0.014 *	0.006	-0.004	0.013	0.035 *	0.008
Changes in tariffs × age	-0.001	0.001	0.001	0.001	-0.001	0.002	-0.001	0.001	0.005	0.003

* $p<0.05$

** $p<0.1$

1. For all plants, exporters and domestic-controlled plants in quartiles 2, 3 and 4, the differences between the adjacent quartile groups are statistically significant at 5%.
2. For exporters in quartiles 2, 3 and 4, the differences between the adjacent quartile groups are statistically significant at 10%. For foreign-controlled plants in quartiles 2, 3 and 4, the differences between the adjacent quartile groups are statistically significant at 5%.

Note: We calculate marginal effects on the basis of equations (4)-(6), using probit coefficients in Table 5 and 'nlcom' command in STATA. Marginal effects by quartiles are evaluated at the common two-digit industry mean values of all variables, except the variable of interest, whose quartile-specific industry mean values are used. We evaluate marginal effects by groups at common two-digit industry mean values of relative productivity, relative employment, and age (thus controlling for plant characteristics between groups), and at the group-specific two-digit industry mean values of relative productivity, employment, and age (thus allowing plant characteristics to vary between groups). In both cases, common two-digit industry mean values of tariff and real-exchange-rate changes are used.

Table 7
Marginal effects of changes in real exchange rates on plant exit

	All plants		Non-exporters		Exporters		Domestic-controlled plants		Foreign-controlled plants	
	estimate	standard error	estimate	standard error	estimate	standard error	estimate	standard error	estimate	standard error
Marginal effects of real-exchange-rate changes										
After controlling for plant characteristics between groups	0.003 *	0.001	0.001	0.002	0.011 *	0.003	0.002	0.001	0.007 *	0.002
Difference of being an exporter or a foreign-controlled plant					0.009 *	0.003			0.005 **	0.003
Allowing plant characteristics to vary between groups	0.003 *	0.001	0.002	0.001	0.008 *	0.002	0.002	0.001	0.005 *	0.002
Difference of being an exporter or a foreign-controlled plant					0.007 *	0.002			0.004	0.002
By relative labour productivity quartile										
Quartile 1 (low)	0.008 *	0.003	0.003	0.003	0.020 *	0.006	0.004	0.004	0.018 *	0.006
Quartile 2[1]	0.005 *	0.002	0.002	0.002	0.016 *	0.005	0.002	0.002	0.010 *	0.004
Quartile 3[1]	0.003 *	0.001	0.002	0.001	0.011 *	0.005	0.001	0.001	0.006	0.004
Quartile 4 (high)[1]	-0.005	0.004	-0.001	0.005	-0.006	0.006	-0.002	0.005	-0.011 **	0.006
By relative employment quartile										
Quartile 1 (low)	-0.002	0.004	0.001	0.006	0.004	0.006	-0.003	0.005	0.002	0.005
Quartile 2	-0.001	0.003	0.001	0.004	0.004	0.006	-0.002	0.004	0.003	0.004
Quartile 3	0.001	0.001	0.002	0.002	0.004	0.005	0.000	0.002	0.003	0.003
Quartile 4 (high)	0.013	0.009	0.004	0.013	0.006	0.009	0.012	0.012	0.005	0.010
By age quartile										
Quartile 1 (low)	0.007 **	0.004	0.007 **	0.004	0.005	0.012	0.006	0.004	0.009	0.012
Quartile 2	0.005 *	0.002	0.004 **	0.002	0.005	0.008	0.004 **	0.002	0.007	0.007
Quartile 3	0.001	0.002	-0.001	0.003	0.005	0.005	-0.001	0.002	0.003	0.005
Quartile 4 (high)	0.000	0.003	-0.002	0.004	0.005	0.008	-0.003	0.004	0.002	0.007
Marginal interaction effects										
Changes in real exchange rates × relative productivity	-0.003 *	0.001	-0.001	0.002	-0.005 *	0.002	-0.002	0.002	-0.004 *	0.001
Changes in real exchange rates × relative employment	0.002	0.002	0.0003	0.003	-0.00004	0.001	0.002	0.002	0.0002	0.001
Changes in real exchange rates × age	-0.0003	0.0003	-0.0004	0.0003	-0.00005	0.0005	-0.0004	0.0003	-0.0002	0.0006

* $p<0.05$
** $p<0.1$

1. For all plants, exporters and foreign-controlled plants in quartiles 2, 3 and 4, the differences between the adjacent quartile groups are statistically significant at 5%.

Note: We calculate marginal effects on the basis of equations (4)-(6), using probit coefficients in Table 5 and 'nlcom' command in STATA. Marginal effects by quartiles are evaluated at the common two-digit industry mean values of all variables, except the variable of interest, whose mean values of the quartile-specific industry mean values are used. We evaluate marginal effects by groups at common two-digit industry mean values of relative productivity, relative employment, and age (thus controlling for plant characteristics between groups), and at the group-specific two-digit industry mean values of relative productivity, employment, and age (thus allowing plant characteristics to vary between groups). In both cases, common two-digit industry mean values of tariff and real-exchange-rate changes are used.

Table 8
Marginal effects of plant characteristics on exit: all plants

	estimate	standard error
Relative productivity	-0.019 *	0.0030
Relative employment	-0.049 *	0.0030
Age	-0.012 *	0.0004

* p<0.05

Note: We calculate marginal effects on the basis of equations (4)-(6), using probit coefficients in Table 5 and 'nlcom' command in STATA. We evaluate marginal effects at the two-digit industry mean values of all variables.

Table 9
Predicted probability of exit

	estimate	standard error
All plants	0.343 *	0.002
By export status		
Non-exporters	0.372 *	0.002
Exporters	0.210 *	0.003
Difference (marginal effect of being an exporter)	-0.162 *	0.004
By ownership status		
Domestic-controlled plants	0.357 *	0.002
Foreign-controlled plants	0.264 *	0.004
Difference (marginal effect of being a foreign-controlled plant)	-0.093 *	0.004

* p<0.05

Note: Predicted probability is based on probit coefficients in Table 5, and evaluated at the common two-digit industry mean values of trade cost and real exchange rate changes, and at the group-specific two-digit industry mean values of relative productivity, relative employment, and age (this allows for plant characteristics to vary across groups).

Table 10
Predicted probability of exit: all plants

	1979 to 1984		1984 to 1990		1990 to 1996	
	estimate	standard error	estimate	standard error	estimate	standard error
Predicted exit rate for scenario						
1: changes in tariffs = 0, changes in real exchange rates=0	29.6 *	0.006	24.0 *	0.013	22.4 *	0.017
2: changes in tariffs =actual changes, changes in real exchange rates=0	34.6 *	0.002	31.2 *	0.011	37.5 *	0.013
3: changes in tariffs = 0, changes in real exchange rates=actual changes	29.4 *	0.005	26.8 *	0.008	19.8 *	0.014
4: changes in tariffs = actual changes, changes in real exchange rates=actual	34.4 *	0.002	34.3 *	0.002	34.2 *	0.002
Difference between scenarios						
2 and 1 (predicted exit rate resulting from tariff changes)	5.0 *	0.005	7.2 *	0.008	15.1 *	0.015
3 and 1 (predicted exit rate resulting from real-exchange-rate changes)	-0.2 *	0.001	2.8 *	0.010	-2.5 *	0.010

	1979 to 1984	1984 to 1990	1990 to 1996
		percent	
Actual average changes in tariffs over the period	-1.1	-2.0	-3.7
Actual average changes in real exchange rates over the period	-0.9	9.4	-11.1

* $p<0.05$

Note: Predicted probability is evaluated at mean values of all variables. An alternative is to derive average predicted probabilities over all observations. The two methods yield very similar results.

Table 11
Predicted probability of exit: by export status

	1979 to 1984		1984 to 1990		1990 to 1996	
	estimate	standard error	estimate	standard error	estimate	standard error
Non-exporters						
Predicted exit rate for scenario						
1: changes in tariffs = 0, changes in real exchange rates=0	32.7 *	0.006	29.0 *	0.015	26.6 *	0.02
2: changes in tariffs =actual changes, changes in real exchange rates=0	37.0 *	0.002	35.2 *	0.013	39.9 *	0.014
3: changes in tariffs = 0, changes in real exchange rates=actual changes	32.7 *	0.006	30.6 *	0.009	24.9 *	0.016
changes in real exchange rates=actual changes	36.9 *	0.002	36.9 *	0.002	37.8 *	0.002
Difference between scenarios						
2 and 1 (predicted exit rate resulting from tariff changes)	4.3 *	0.006	6.2 *	0.009	13.2 *	0.017
3 and 1 (predicted exit rate resulting from real-exchange-rate changes)	-0.04	0.000	1.6	0.012	-1.7	0.012
4 and 1 (predicted exit rate resulting from changes in tariffs and real exchange rates)	4.2 *	0.006	7.9 *	0.016	11.2 *	0.020
Exporters						
Predicted exit rate for scenarios						
1: changes in tariffs = 0, changes in real exchange rates=0	15.9 *	0.011	6.7 *	0.014	8.2 *	0.022
2: changes in tariffs =actual changes, changes in real exchange rates=0	22.0 *	0.004	13.7 *	0.017	29.3 *	0.029
3: changes in tariffs = 0, changes in real exchange rates=actual changes	14.3 *	0.011	11.3 *	0.013	4.7 *	0.013
changes in real exchange rates=actual changes	20.0 *	0.005	21.1 *	0.004	20.5 *	0.005
Difference between scenarios						
2 and 1 (predicted exit rate resulting from tariff changes)	6.1 *	0.012	7.0 *	0.012	21.2 *	0.025
3 and 1 (predicted exit rate resulting from real-exchange-rate changes)	-1.6 *	0.004	4.6 *	0.010	-3.5 *	0.013
4 and 1 (predicted exit rate resulting from changes in tariffs and real exchange rates)	4.0 *	0.012	14.4 *	0.014	12.4 *	0.018

	1979 to 1984	1984 to 1990	1990 to 1996
		percent	
Non-exporters			
Actual average changes in tariffs over the period (in percentage)	-1.1	-1.7	-3.5
Actual average changes in real exchange rates over the period (in percentage)	-0.3	11.1	-11.5
Exporters			
Actual average changes in tariffs over the period (in percentage)	-1.0	-1.7	-3.2
Actual average changes in real exchange rates over the period (in percentage)	-2.5	10.0	-9.8

* $p<0.05$

Note: Predicted probability is evaluated at the group mean values of all variables. An alternative is to derive average predicted probabilities over all observations by group. The two methods yield very similar results.

Table 12
Predicted probability of exit: by ownership control status

	1979 to 1984		1984 to 1990		1990 to 1996	
	estimate	standard error	estimate	standard error	estimate	standard error
Domestic-controlled plants						
Predicted exit rate for scenarios						
1: changes in tariffs = 0, changes in real exchange rates=0	30.6 *	0.006	26.4 *	0.015	23.0 *	0.019
2: changes in tariffs =actual changes, changes in real exchange rates=0	35.6 *	0.002	33.5 *	0.013	38.0 *	0.014
3: changes in tariffs = 0, changes in real exchange rates=actual changes	30.5 *	0.006	28.1 *	0.008	21.4 *	0.015
changes in real exchange rates=actual changes	35.5 *	0.002	35.4 *	0.002	36.0 *	0.002
Difference between scenarios						
2 and 1 (predicted exit rate resulting from tariff changes)	5.0 *	0.006	7.1 *	0.008	15.0 *	0.016
3 and 1 (predicted exit rate resulting from real-exchange-rate changes)	-0.1	0.001	1.7	0.012	-1.6	0.011
4 and 1 (predicted exit rate resulting from changes in tariffs and real exchange rates)	4.9 *	0.006	9.0 *	0.015	13.0 *	0.019
Foreign-controlled plants						
Predicted exit rate for scenarios						
1: changes in tariffs = 0, changes in real exchange rates=0	21.6 *	0.013	13.8 *	0.023	16.4 *	0.040
2: changes in tariffs =actual changes, changes in real exchange rates=0	28.1 *	0.004	22.4 *	0.022	29.1 *	0.027
3: changes in tariffs = 0, changes in real exchange rates=actual changes	21.4 *	0.013	17.7 *	0.018	12.6 *	0.032
changes in real exchange rates=actual changes	27.9 *	0.004	27.7 *	0.006	23.6 *	0.006
Difference between scenarios						
2 and 1 (predicted exit rate resulting from tariff changes)	6.6 *	0.014	8.7 *	0.018	12.7 *	0.035
3 and 1 (predicted exit rate resulting from real-exchange-rate changes)	-0.2 *	0.001	4.0 *	0.013	-3.8 **	0.021
4 and 1 (predicted exit rate resulting from changes in tariffs and real exchange rates)	6.3 *	0.014	13.9 *	0.024	7.2 *	0.037

	1979 to 1984	1984 to 1990	1990 to 1996
		percent	
Domestic-controlled plants			
Actual average changes in tariffs over the period (in percentage)	-1.1	-1.7	-3.5
Actual average changes in real exchange rates over the period (in percentage)	-0.6	11.2	-11.1
Foreign-controlled plants			
Actual average changes in tariffs over the period (in percentage)	-1.0	-1.8	-2.9
Actual average changes in real exchange rates over the period (in percentage)	-0.4	9.7	-11.5

* $p<0.05$

Note: Predicted probability is evaluated at the group mean values of all variables. An alternative is to derive average predicted probabilities over all observations by group. The two methods yield very similar results.

References

Ai, C., and E.C. Norton. 2003. "Interaction terms in logit and probit models." *Economics Letters*. Vol. 80. No. 1. p. 123–129.

Baggs, J., E. Beaulieu, and L. Fung. 2009. "Firm survival, performance, and the exchange rate." *Canadian Journal of Economics*. Vol. 42. No. 2. p. 393–421.

Baldwin, J.R. 1995. *The Dynamics of Industrial Competition: A North American Perspective*. Cambridge (United Kingdom). Cambridge University Press.

Baldwin, J.R., L. Bian, R. Dupuy, and G. Gellatly. 2000. *Failure Rates for New Canadian Firms: New Perspectives on Entry and Exit*. Statistics Canada Catalogue no. 61-526-XIE. Ottawa.

Baldwin, J.R., G. Gellatly, and V. Gaudreault. 2002. *Financing Innovation in New Small Firms: New Evidence from Canada*. Statistics Canada Catalogue no. 11F0019MIE. Ottawa. Analytical Studies Branch Research Paper Series. No. 190.

Baldwin, J.R., and W. Gu. 2003. "Export-market participation and productivity performance in Canadian manufacturing." *Canadian Journal of Economics*. Vol. 36. No. 3. p. 634–657.

Baldwin, J.R., and W. Gu. 2006. "Plant turnover and productivity growth in Canadian manufacturing." *Industrial & Corporate Change*. Vol. 15. No. 3. p. 417–465.

Baldwin, J.R., and W. Gu. 2009. "The impact of trade on plant scale, production-run length and diversification." *Producer Dynamics: New Evidence from Micro Data*. T. Dunne, J.B. Jensen, and M.J. Roberts (eds.). Chicago. University of Chicago Press.

Baldwin, J.R., and B. Yan. 2007. "Exchange rate cycles and Canada/US manufacturing prices." *Review of World Economics*. Vol. 143. No. 3. p. 508–533.

Bernard, A.B., and J.B. Jensen. 2002. *The Deaths of Manufacturing Plants*. Cambridge (Massachusetts). National Bureau of Economic Research. NBER Working Paper Series. Working Paper 9026.

Bernard, A.B., J.B. Jensen, and P.K. Schott. 2003. *Falling Trade Costs, Heterogeneous Firms, and Industry Dynamics*. Cambridge (Massachusetts). National Bureau of Economic Research. NBER Working Paper Series. Working Paper 9639.

Bernard, A.B., J. Eaton, B.J. Jensen, and S. Kortum. 2003. "Plants and productivity in international trade." *American Economic Review*. Vol. 93. No. 4. p. 1268–1290.

Brainard, S.L., and D.A. Riker. 1997. "*Are U.S. multinationals exporting U.S. jobs?*" Cambridge (Massachusetts). National Bureau of Economic Research. NBER Working Paper Series. Working Paper 5958.

Caves, R.E. 1998. "Industrial organization and new findings on the turnover and mobility of firms." *Journal of Economic Literature*. Vol. 36. No. 4. p. 1947–1982.

Caves, R.E. 2007. *Multinational Enterprise and Economic Analysis*. Cambridge (Massachusetts). Cambridge University Press.

Dunne, T., M.J. Roberts, and L. Samuelson. 1988. "Patterns of firm entry and exit in U.S. manufacturing industries." *RAND Journal of Economics*. Vol. 19. No. 4. p. 495–515.

Ericson, R., and A. Pakes. 1995. "Markov-perfect industry dynamics: A framework for empirical work." *Review of Economics Studies*. Vol. 62. No. 210. p. 53–82.

Fung, L. 2008. "Large real exchange rate movements, firm dynamics and productivity growth." *Canadian Journal of Economics*. Vol. 41. No. 2. p. 391–424.

Geroski, P.A. 1995. "What do we know about entry?" *International Journal of Industrial Organization*. Vol. 13. No. 4. p. 421–440.

Görg, H., and E. Strobl. 2003. " 'Footloose' multinationals?" *Manchester School (14636786)*. Vol. 1. No. 1. p. 1–19.

Gu, W., G. Sawchuk, and L.W. Rennison 2003. "The effect of tariff reductions on firm size and firm turnover in Canadian manufacturing." *Review of World Economics*. Vol. 139. No. 3. p. 440–459.

Harris, R.I.D., and Q.C. Li. 2007. *Firm Level Empirical Study of the Contribution of Exporting to UK Productivity Growth*. Report to UK Trade & Investment. Electronic resource: https://www.uktradeinvest.gov.uk/UKTI/fileDownload/FAMEFinalReport2007v2.pdf?cid=401169 (accessed on December 15, 2009).

Head, K., and J. Ries. 1999. "Rationalization effects of tariff reductions." *Journal of International Economics*. Vol. 47. No. 2. p. 295–320.

Johnson, J., J.R. Baldwin, and C. Hinchley. 1997. *Successful Entrants: Creating the Capacity for Survival and Growth*. Statistics Canada Catalogue no. 61-524-XPE. Ottawa.

Jovanovic, B. 1982. "Selection and the evolution of industry." *Econometrica*. Vol. 50. No. 3. p. 649–670.

Li, J., and S. Guisinger 1991. "Comparative business failures of foreign-controlled firms in the United States." *Journal of International Business Studies*. Vol. 22. No. 2. p. 209–224.

Lileeva, A. 2008. "Trade liberalization and productivity dynamics: Evidence from Canada." *Canadian Journal of Economics*. Vol. 41. No. 2. p. 360–390.

Melitz, M.J. 2003. "The impact of trade on intra-industry reallocations and aggregate industry productivity." *Econometrica*. Vol. 71. No. 6. p. 1695–1725.

Melitz, M.J., and G.I.P. Ottaviano. 2008. "Market size, trade and productivity." *Review of Economic Studies*. Vol. 75. No. 1. p. 295–316.

Norton, E.C., H. Wang, and C. Ai. 2004. "Computing interaction effects and standard errors in logit and probit models." *The Stata Journal*. Vol. 4. No. 2. p. 154–167.

Pakes, A., and R. Ericson. 1998. "Empirical implications of alternative models of firm dynamics." *Journal of Economic Theory*. Vol. 79. No. 1. p. 1–45.

Pérez, S.E., A.S. Llopis, and J.A.S. Llopis. 2004. "The determinants of survival of Spanish manufacturing firms." *Review of Industrial Organization*. Vol. 25. No. 3. p. 251–273.

Riker, D.A., and S.L. Brainard. 1997. *U.S. Multinationals and Competition from Low Wage Countries*. Cambridge (Massachusetts). National Bureau of Economic Research. NBER Working Paper Series. Working Paper 5959.

Rispoli, L., 2009. *Measuring the Contribution of the Unincorporated Sector in the Canadian Economy, 1997 to 2002*. Statistics Canada Catalogue no. 11-624-M. Ottawa. Insights on the Canadian Economy. No. 023.

Stinchcombe, A.L. 1965. "Social structure and organizations." *Handbook of Organizations*. J. March (ed.). Chicago. Rand McNally. p. 142–193.

Trefler, D. 2004. "The long and short of the Canada-U.S. Free Trade Agreement." *American Economic Review* . Vol. 94. No. 4. p. 870–895.

Venables, A.J. 1985. "Trade and trade policy with imperfect competition: the case of identical products and free entry." *Journal of International Economics*. Vol. 19. No. 1. p. 1–19.

Venables, A.J. 1987. "Trade and trade policy with differentiated products: A Chamberlinian-Ricardian model." *Economic Journal*. Vol. 97. No. 387. p. 700–717.

Wernerfelt, B. 1984. "A resource-based view of the firm." *Strategic Management Journal*. Vol. 5. No. 2. p. 171–180.

Yeaple, S.R. 2002. *A Simple Model of Firm Heterogeneity, International Trade and Wages*. University of Pennsylvania. Mimeo.

Economic Analysis (EA)
Research Paper Series
Catalogue No. 11F0027M

No. 001 A Comparison of Canada-U.S. Economic Growth in the Information Age, 1981-2000: The Importance of Investment in Information and Communication Technologies, **Philip Armstrong, Tarek M. Harchaoui, Chris Jackson and Faouzi Tarkhani (March 1, 2002)**

No. 002 Purchasing Power Parity: A Canada/U.S. Exploration, **Beiling Yan (May 2002)**

No. 003 The Trend to Smaller Producers in Manufacturing: A Canada/U.S. Comparison, **John Baldwin, Ron S. Jarmin, Jianmin Tang (May 2002)**

No. 004 Foreign Affiliate Trade Statistics – 1999: How Goods and Services are Delivered in International Markets, **Balance of Payments Division, Colleen Cardillo (April 2002)**

No. 005 Regional Manufacturing Employment Volatility in Canada: The Effects of Specialization and Trade, **John Baldwin and W.Mark Brown (April 11, 2003)**

No. 006 Growth History, Knowledge Intensity and Capital Structure in Small Firms, **G. Gellatly, S. Thornhill, A. Riding (August 6, 2003)**

No. 007 Accounting for Greenhouse Gases in the Standard Productivity Framework, **Tarek Harchaoui, Dmitry Kabrelyan and Rob Smith (November 1, 2002)**

No. 008 Overcoming Distance, Overcoming Borders: Comparing North American Regional Trade, **W. Mark Brown (April 16, 2003)**

No. 009 Assessing the Impact of Greenhouse Gas Emissions on Canada's Productivity Growth, 1981-1996: An Expermental Approach, **Tarek M. Harchaoui and Pierre Lasserre (November 1, 2002)**

No. 010 A Frontier Approach to Canada-U.S. Multifactor Productivity Performance, **Kaïs Dachraoui, Tarek M. Harchaoui (April 3, 2003)**

No. 011 Participation in Export Markets and Productivity Performance in Canadian Manufacturing, **John R. Baldwin, Wulong Gu (August 13, 2003)**

No. 012 Impact of Advanced Technology Use on Firm Performance in the Canadian Food Processing Sector, **John R.Baldwin, David Sabourin and David Smith (June 3, 2003)**

No. 013 Foreign Affiliate Trade Statistics – Canadian Operations Abroad, 1999 to 2001- **Balance of Payments Division, Michael Marth (May 2003)**

No. 014 The Effect of Tariff Reductions on Firm Size and Firm Turnover in Canadian Manufacturing, **Wulong Gu, G.Sawchuk, L.Whewell (August 19, 2003)**

No. 015 The Sources of Growth of the Canadian Business Sector's CO2 Emissions, 1990-1996, **Kaïs Dachraoui, Gerry Gravel, Tarek M. Harchaoui and Joe St. Lawrence (September 2003)**

No. 016 The Impact of Self-employment on Labour Productivity Growth: A Canada and United States Comparison, **John R. Baldwin, James Chowhan (August 21, 2003)**

No. 017 Public Capital and Its Contribution to the Productivity Performance of the Canadian Business Sector, **Tarek M. Harchaoui and Faouzi Tarkhani (November 12, 2003)**

No. 018 Prosperity and Productivity: A Canada-Australia Comparison, **Tarek M. Harchaoui, Jimmy Jean and Faouzi Tarkhani (December 9, 2003)**

No. 019 Hollowing-out, trimming-down or scaling-up? An Analysis of head Offices in Canada, 1999-2002, **John Baldwin, Desmond Beckstead and W. Mark Brown (December 8, 2003)**

No. 020 The Effect of Changing Technology Use on Plant Performance in the Canadian Manufacturing Sector, **John Baldwin and David Sabourin (July 27, 2004)**

No. 021 Industrial Competition, Shifts in Market Share and Productivity Growth. **John Baldwin and Wulong Gu (July 22, 2004)**

No. 022 Innovation, Survival and Performance of Canadian Manufacturing Plants. **John Baldwin and Wulong Gu (September 2004)**

No. 023 Renewing Canada's Manufacturing Economy: A Regional Comparison, 1973-1996. **W. Mark Brown (October 21, 2004)**

No. 024 Catching Up and Falling Behind: The Performance of Provincial GDP per Capita from 1990 to 2003. **John R. Baldwin, W. Mark Brown, Jean-Pierre Maynard, Danielle Zietsma (November 9, 2004)**

No. 025 Whatever Happened to Canada-U.S. Economic Growth and Productivity Performance in the Information Age? **Tarek M. Harchaoui and Faouzi Tarkhani (November 23, 2004)**

No. 026 Water Use, Shadow Prices and the Canadian Business Sector Productivity Performance. **Kaïs Dachraoui and Tarek M. Harchaoui (December 1, 2004)**

No. 027 Trade Liberalization: Export-market Participation, Productivity Growth and Innovation. **John Baldwin and Wulong Gu (December 14, 2004)**

No. 028 A Comparison of Canadian and U.S. Productivity Levels: An Exploration of Measurement Issues. **John R. Baldwin, Jean-Pierre Maynard, Marc Tanguay, Fanny Wong and Beiling Yan (January 20, 2005)**

No. 029 Integration and Co-integration: Do Canada-U.S. Manufacturing Prices Obey the 'Law of One Price'?. **André Bernard, Paul Warren and Beiling Yan (February 15,, 2005)**

No. 030 Profitability of Canadian- versus U.S.-Controlled Enterprises. **Paul Warren (March 3, 2005)**

No. 031 Responses to Trade Liberalization: Changes in Product Diversification in Foreign- and Domestic-Controlled Plants. **John R. Baldwin, Richard Caves and Wulong Gu (March 24, 2005)**

No. 032 Canada's Investments in Science and Innovation: Is the Existing Concept of research and Development Sufficient?. **John R. Baldwin, Desmond Beckstead and Guy Gellatly (April 12, 2005)**

No. 033 Death in the Industrial World: Plant Closures and Capital Retirement. **John R. Baldwin (May 4,, 2005)**

No. 034 Foreign Multinationals and Head Office Employment in Canadian Manufacturing Firms. **John R. Baldwin and W. Mark Brown (June 8, 2005)**

No. 035 Demand for Skills in Canada: The Role of Foreign Outsourcing and Information-Communication Technology. **Beiling Yan (October 28, 2005)**

No. 036 Trade Credit and Credit Rationing in Canadian Firms. **Rose Cunningham (November 4, 2005)**

No. 037 Key Indicators in Canada. **Paul Warren (November 30, 2005)**

No. 038 The Impact of Trade on Plant Scale, Production-Run Length and Diversification. **John R. Baldwin and Wulong Gu (May 19, 2006)**

No. 039 How are Canadian Regions Adjusting to a Larger and More Integrated North American Market?. **Wulong Gu and Gary D. Sawchuk (May 31, 2006)**

No. 040 A Proposal for Treating Research and Development as Capital Expenditures in the Canadian SNA. **Meir Salem and Yusuf Siddiqi (June 29, 2006)**

No. 041 Exchange Rate Cycles and Canada–U.S. Manufacturing Prices. **John R. Baldwin and Beiling Yan (June 28, 2006)**

No. 042 Competition, Firm Turnover and Productivity Growth. **John R. Baldwin and Wulong Gu, (September 25, 2006)**

No. 043 Domestic and Foreign Influences on Canadian Prices over Exchange Rate Cycles, 1974 to 1996. **John R. Baldwin and Beiling Yan, (November 8, 2006)**

No. 044 The Ebb and Flow of Comparative Advantage: Trade and the Industrial Specialization of Canadian Manufacturing Regions, 1974 to 1999, **W. Mark Brown (June 25, 2007)**

No. 045 Urban Economies and Productivity, **John R. Baldwin, Desmond Beckstead, W. Mark Brown and David L. Rigby (June 18, 2007)**

No. 046 Real GDP and the Purchasing Power of Provincial Output, **Ryan Macdonald (July 24, 2007)**

No. 047 Estimating TFP in the Presence of Outliers and Leverage Points: An Examination of the KLEMS Datase, **Ryan Macdonald (December 5, 2007)**

No. 048 Canadian and U.S. Real Income Growth Pre and Post 2000: A Reversal of Fortunes, **Ryan Macdonald (November 22, 2007)**

No. 049 Agglomeration Economies: Microdata Panel Estimates from Canadian Manufacturing, **John R. Baldwin, W. Mark Brown and David L. Rigby (February 5, 2008)**

No. 050 An Examination of Public Capital's Role in Production, **Ryan Macdonald (April 15, 2008)**

No. 051 Trade Liberalization and Productivity Dynamics: Evidence from Canada, **Alla Lileeva (May 7, 2008)**

No. 052 Geographic Market Access and the Effects of Trade on Length of Production Run, Product Diversity and Plant Scale of Canadian Manufacturing Plants, 1974 to 1999, **John R. Baldwin, W. Mark Brown and Wulong Gu (May 9, 2008)**

No. 053 Firm Turnover and Productivity Growth in the Canadian Retail Trade Sector, **John R. Baldwin and Wulong Gu (December 8, 2008)**

No. 054 Adapting to Import Competition: Effects of Low-wage Trade on Commodity Mix in Canadian Manufacturing Plants, **John R. Baldwin and Alla Lileeva (May 16, 2008)**

No. 055 Outsourcing and Offshoring in Canada: Trends, Causes and Economic Impact, **John R. Baldwin and Wulong Gu (May 23, 2008)**

No. 056 Plant Divestitures and Acquisitions in the Canadian Manufacturing Sector, **John R. Baldwin, Robert Gibson and Yanling Wang (June 4, 2009)**

No. 057 The Canadian Manufacturing Sector: Adapting to Challenges, **John R. Baldwin and Ryan Macdonald (July 2009)**

No. 058 PPPs: Purchasing Power or Producing Power Parities?, **John Baldwin and Ryan Macdonald (December 2009)**

No. 059 Real Gross Domestic Income, Relative Prices and Economic Performance Across the OECD, **Ryan Macdonald (January 2010)**

No. 060 Plant Size, Nationality, and Ownership Change, **John R. Baldwin and Yanling Wang (February 2010)**